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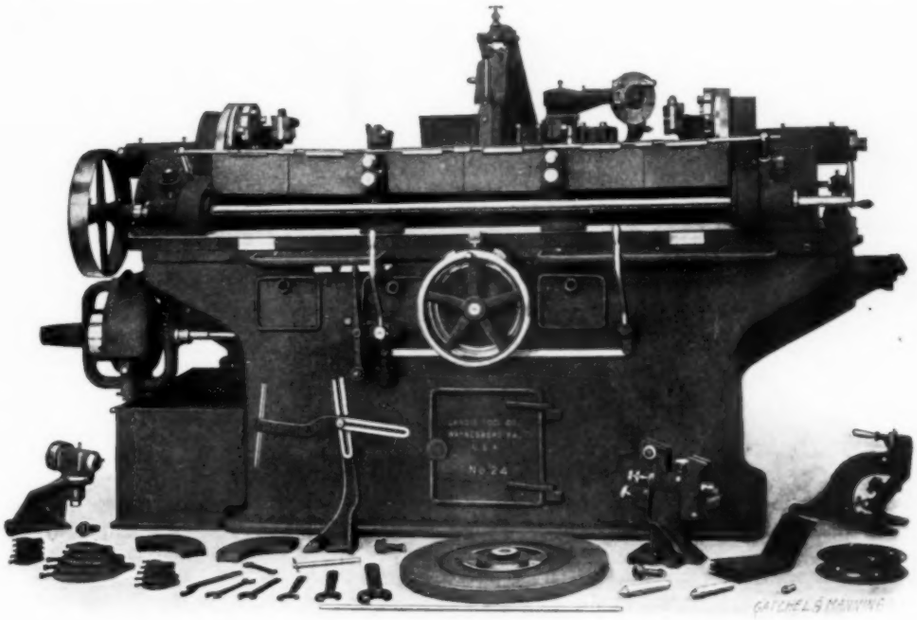

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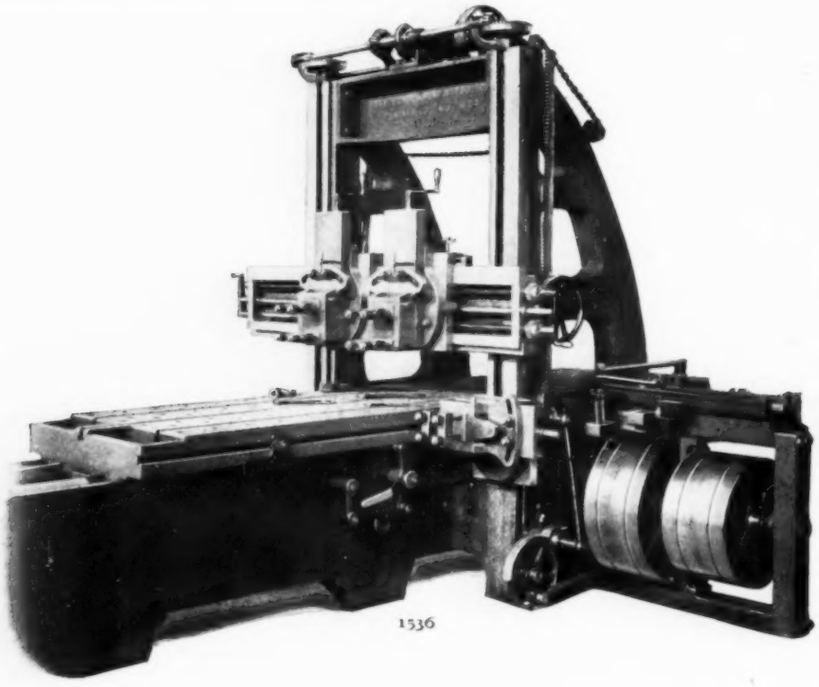

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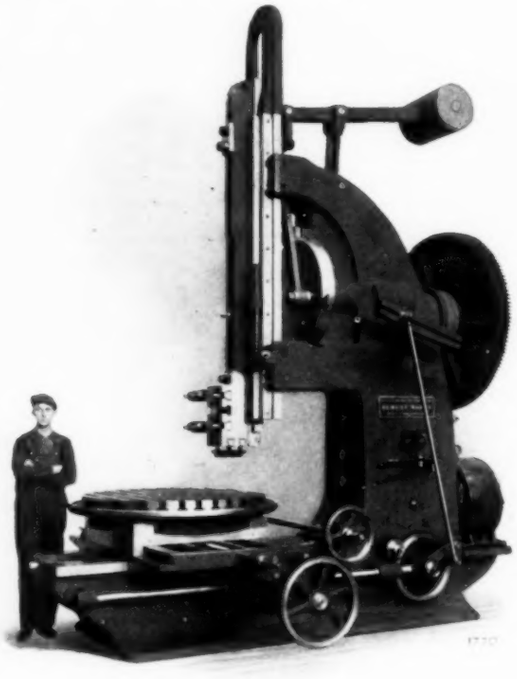

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(*See pages* 51, 52, 53, 54, 55, 56, 57 *and* 58)

The Casting of Bronze Statues

The Delicate and Intricate Work That Is Produced in Sand Molds, Requiring Hundreds of Loose Cores All Made without Core Boxes

BY SNOWDEN B. REDFIELD

What is probably the very highest branch of the molders' art is in the casting of bronze figures and statues. From its very nature it is essential that the bronze casting shall exactly reproduce every contour and every mark that is put upon the plaster figure sent by the artist to the foundry to be cast in bronze. What makes this fine work all the more difficult is the fact that these statues, unlike the patterns for machinery castings, are not parted in the usual sense of the word, and furthermore they are nearly always exceedingly complicated in contour, having many parts which are undercut in order to represent the various portions of the human body, and also the natural folds of the clothing and draperies.

No Core Boxes

The ordinary machinery molder would expect the pattern for this work to be provided with almost an infinite number of core boxes for forming the cores for these undercut parts, and in his imagination the pattern of the main figure would be literally bristling with core prints in which to set these cores. As a matter of fact, an ordinary statue has no core boxes at all, and the number of core prints on the pattern, in the true sense of the word is practically nil.

Many of the most celebrated statues lately designed have been cast in the works of the Gorham Manufacturing Company at Providence, R. I. Fig. 2 is a photograph of one of their products, the Sheridan statue recently erected in Washington, and the horse, which is also shown in Fig. 1 as suspended from the shop crane, is said to be the only equestrian figure of any size which has been cast in one piece in this country. It is also said that this casting is the largest single piece bronze casting ever poured in this country.

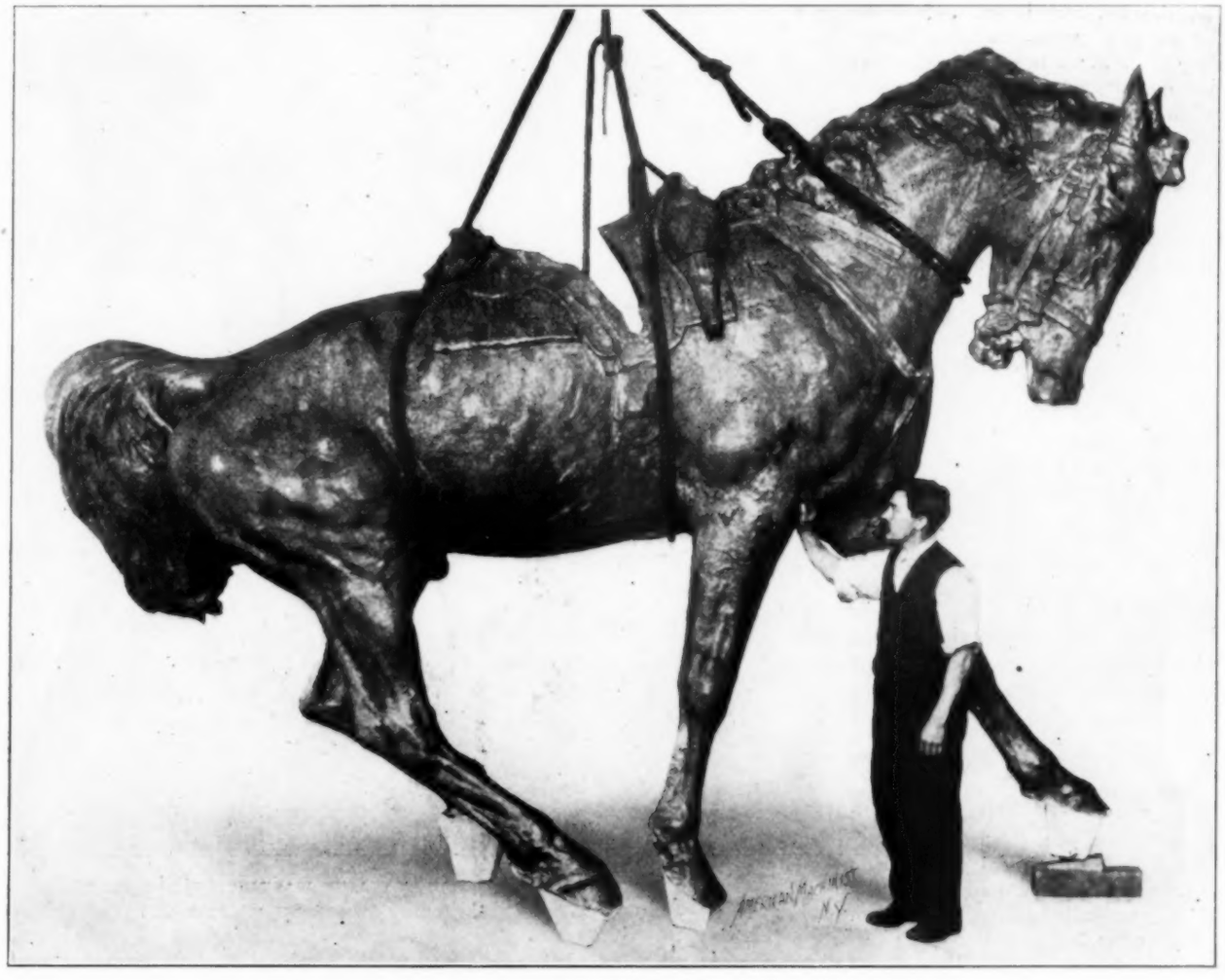


FIG. 1. PART OF SHERIDAN STATUE, WASHINGTON, D. C., SAID TO BE THE ONLY BRONZE HORSE OF LARGE SIZE EVER CAST IN A SINGLE PIECE IN THIS COUNTRY

From these remarks it will be surmised that statues are not all made in one piece. This is true, for many of the projecting parts, such as arms and legs, are cast separate and afterward fastened onto the main casting, this fastening being so perfectly done that it is practically impossible to detect the joint. Horses are usually cast in eight pieces, so that the one shown

in Fig. 1 is really a remarkable piece of work. The method of making the joints will be described later on.

Ramming the Mold

First as to the casting. Let us imagine a figure with flowing drapery and with the head and arms and feet all in one piece. The molder first selects that plane in which it will be easiest to split his mold into the cope and drag, although as already said the pattern itself is not split, but is a plaster model, an exact duplicate of the clay figure made by the artist himself. This figure is then buried in sand in the cope up to the level convenient for parting the mold, it, usually, being laid down on its side. The sand is smoothed off around the figure and soapstone is applied to the sand surface to make a parting.

After this the drag is put on and the molder using a special grade of French molding sand, which is very sticky, rams a small quantity of this sand into every one of the undercut parts on the upper side of the plaster figure which will not draw out of the mold when completed, confining himself to but a small portion at a time. He packs this sand in tightly with a small hammer, and after trimming the edges, he carefully lifts out this small core, so made, by means of a pointed wire. Next he dusts it all over with soapstone to give it a parting surface, and then lays it back in place. He now proceeds to the next undercut section, which may be a continuation of what he has already been working upon and makes another little core, which fits the undercut part of the plaster figure and also fits right up to the small core already made. This little piece of new core is now lifted out, dusted over with soapstone and put back as before. This is repeated until every undercut portion of the figure which is exposed above the main sand has been provided with a little core, and each one of these cores can be lifted out separately, while all their combined outside surfaces form such a shape that it will easily draw out from any mold which is made on the upper half of the figure.

When all the little cores have been made, and it will be noticed that no core box other than the portions of the main pattern itself has been used, the whole figure is practically covered over with these little cores, and next the whole surface is soapstoned and the drag of the mold is filled in with this same special molding sand, being rammed down and strengthened with jaggers until the drag is full. It is next necessary to turn over the entire mold with all the parts in place, and then to remove the cope with its preliminary sand filling, and by repeating the process of making a complete set of little cores for this other side of the plaster figure, the cope of the mold is made in the same way.

Now when the mold is taken apart by lifting off the cope the sand will come away from the pattern and little cores, leaving all these little cores still in place against the plaster pattern. The cope is turned over, and each little core is then lifted out separately from its place on the pattern and placed other side up in its own print in the cope, which was formed by the ramming up of the sand in the cope. It will be seen that when all these little cores have been put into the cope their exposed surfaces will form the exact reverse of the plaster pattern, no matter how many undercut portions there were in the drapery of the figure or in the features of the body. The drag is then removed from the other side of the pattern and after turning over, its own cores are set back into their prints, just as was done for the cope. When all the cores are in place in both the cope and the drag, the mold is complete in every exterior detail, being an exact reproduction of the plaster cast only, of course, in the reverse.

The Inside Core

Everybody knows that bronze statues are hollow, and when in ordinary sizes they are not much more than ¼ or ⅜ inch thick, and as these hollow parts extend throughout the statue, it may be imagined that this core work is also quite complicated. In spite of this it can be again stated that absolutely no core box is used even to furnish the complicated core of the inside of a statue.

In order to make the main core of the statue, the completed mold, bolted together with all its little cores in place, but without the plaster pattern, is carefully filled with the molding sand, and this sand is rammed in from a suitable opening, usually at the bottom of the figure, an iron framework, called the "armature" being used to stiffen the core. This operation forms a complete sand figure, an exact reproduction of the plaster pattern, right side before and of the same size. The mold is next carefully taken apart, and, of course, the little loose cores inside will come away, attaching themselves to the main inside core by means of the various undercut sections. These little cores are then carefully removed from the main core and placed back into the two halves of the mold, leaving the main core a complete figure.

FIG. 2. THE COMPLETE SHERIDAN STATUE, WASHINGTON, D. C., CAST BY GORHAM MANUFACTURING COMPANY, PROVIDENCE, R. I.

This main core is next covered over with soapstone and the molder uses a small, sharp knife to go over the entire surface of the main core, shaving away a thickness of sand equal to the thickness of metal desired in the finished statue. The soapstone coating helps to guide him so that he can tell just what parts have been shaved and which parts have not. This leaves a complete sand figure similar to the plaster pattern, with the exception that it is smaller in every direction by an amount equal to twice the thickness of the metal, and, of course, in this process of shaving many of the details have been eliminated, as these details are not at all necessary on the inside of the statue, which nobody can see. Fig. 4 shows the loose corework, and at the left center of the picture a workman is constructing a wire armature for an inside core to fill an outside loose core.

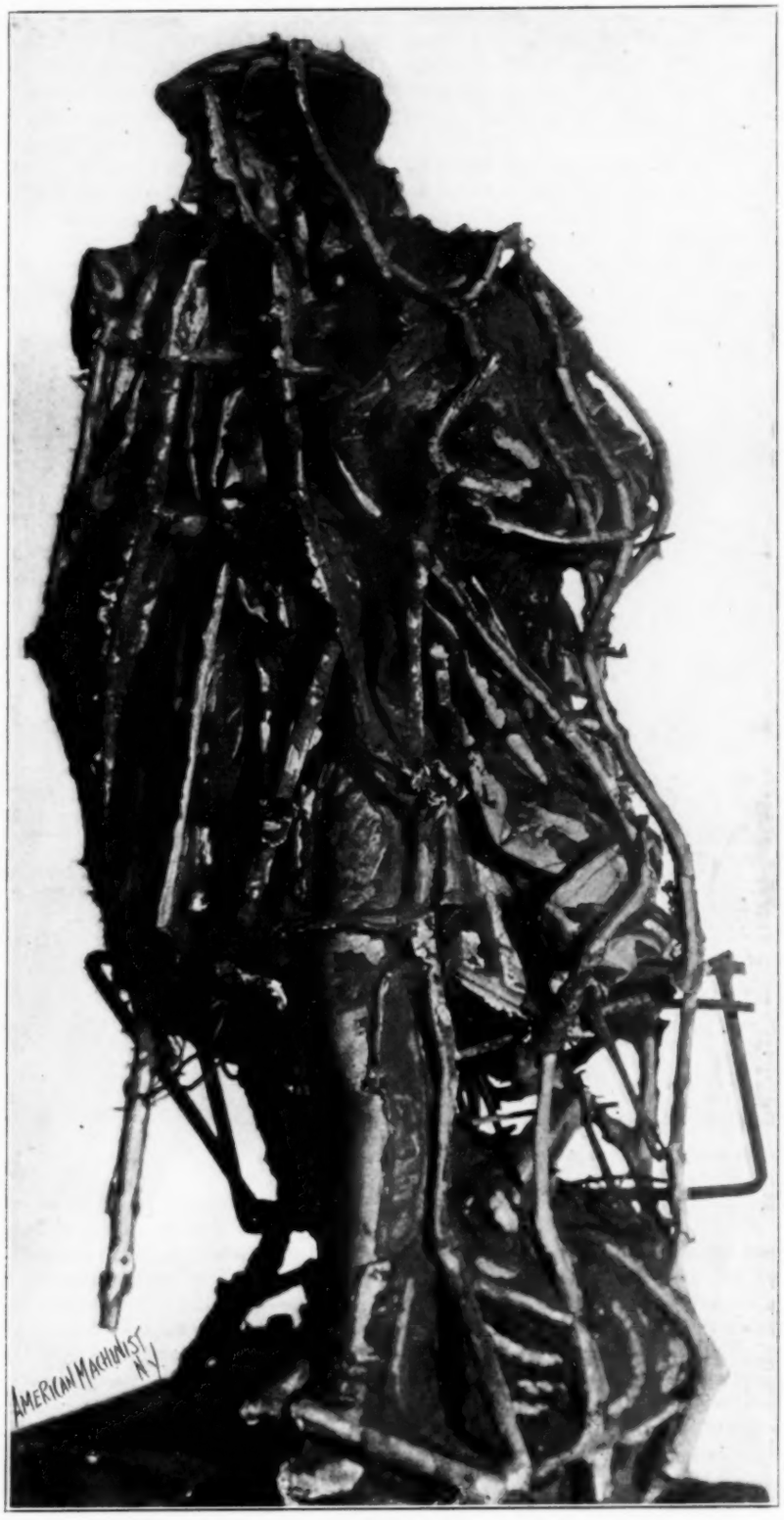


FIG. 3. STERLING SILVER STATUE OF COLUMBUS, 8 FEET HIGH; SHOWING "GRAPE VINE," BEFORE CLEANING

In order to support the main core inside of the mold steel pins are run into the core right on the parting line of the main mold, so that the core is supported at various points on the parting line. These steel pins differ from chaplets, in that the pins will stick through the bronze, projecting from both sides of the metal. After the metal has been poured and cooled, these pins are pulled out by main force and the small holes are plugged up with bronze and finished over the outside surfaces so as to be entirely hidden. It is not possible to use bronze chaplets, because being so small and melting at a comparatively low temperature they would melt down almost as soon as the main body of hot metal struck them, which would, of course, allow the core to drop down out of place.

The inside surfaces of the mold are next given a coat of blacking and the mold is then put into a hot oven where, with an intense heat of long duration, every particle of moisture is driven from the sand. In statue work it is absolutely essential that the molten metal be forced into intimate contact with the sand, because the surface of the mold has in it all the various marks, indentations and scorings given by the artist, in order to represent folds, creasings, and even the fabric out of which the draperies are supposed to be made. The baking for such a long period is to insure that the metal shall come into this intimate contact with the sand by the removal of all the moisture, and as the pouring is done while the sand is still hot, chilling of the metal is to some extent prevented.

"The Grapevine"

With castings having walls so thin as these statues and spread over so large a surface in comparison to their weight, it is necessary to take still other precautions to insure that the metal will reach every part of the mold before it chills. To insure this there are many gates and passages leading through the mold to all parts of statue. This is shown in a remarkable way in Fig. 3, which shows a sterling-silver statue of Columbus 8 feet high just after it was taken from the mold and before trimming. Some few of the metal parts shown around this statue are braces in the mold to hold the sand and support the inside core, but by far the greater portion, the "grape vine," as it is called, is composed of these gates and passages leading from the pouring gate to every part of the mold.

To further insure that every part shall be filled, and also again to bring the metal into intimate contact with the sand, a considerable hydrostatic head of metal is provided by a reservoir elevated some little distance above the mold, this reser-

voir being full of molten metal while it is flowing into the mold, and during solidification. The large body of metal in the grape vine and in the reservoir also insures freedom from shrinkage cracks. As the metal chills it, of course, shrinks, and if it were thin, as in the statue itself, there would not be enough metal to draw upon to prevent it from pulling apart. However, the comparatively heavy parts of the grape vine contain a considerable body of metal, and although this hardens on the outside, the center of each one of these metal ducts will remain molten, and at the air risers it can be seen that as shrinkage takes place the still molten metal in the center of these ducts and gates draws down, tending to keep the molds completely full. An imperfect casting is, of course, an expensive thing, and special skill and pains are required of the molder to insure that the casting will be complete and perfect when taken from the mold.

The Joints

As already intimated, some parts of certain statues which project too much to be conveniently cast in one piece are cast separate from the main body. Sometimes the heads are cast separate, and nearly always parts of the arms and legs, although as already said in the case of the Sheridan statue, the horse, which under ordinary circumstances would be cast in eight pieces, was made in one.

To make the joints in the statues brazing or welding has not yet been successfully accomplished, because the bronze when hot is very brittle. Soldered joints are imperfect and difficult to hide, and for this reason the only alternative left is skilful mortise-and-tenon work. Suppose, for instance, that a head is to be attached to a statue by this mortise-and-tenon method, the portion of the body around the collar would be cast with a taper flange turned in, and the head, or rather the neck, would be continued in a tapered extension to exactly fit the taper of the turned-in flange.

The two tapers are cast from the same pattern by the core method already described, but it necessarily does not form an exact fit, and very often there are some rough spots on the parts. It is essential, however, that these two parts shall exactly fit, and this is accomplished by white leading the parts, placing them together noting the high spots, as shown in the white lead, and then filing and scraping off these high spots one after another until the parts come together perfectly. It may take several days to make such a joint as this, but when properly done it is practically impossible of detection by the naked eye. It is usually so arranged also, that the line of parting is made at some point where it will not show, due to a wrinkle in the flesh, or in the drapery as the case may be. It is, however, almost impossible to discover these joints even when there is nothing to hide them except the skill of the mechanic.

So much for the fitting together, but it is, of course, necessary to hold the parts rigidly in place so that they cannot fall out, or become in the slightest degree misplaced. To hold the parts together they are forced strongly into place, and then holes are drilled through the outside of the statue, passing through the two inside flanges and locking the whole thing together. These holes are drilled on angles such that when bronze pins are driven tightly into the holes the tendency is to wedge all the parts rigidly into place. When the bronze pins have been driven home, the ends are cut off, filed and chased to represent the rest of the surface of the statue, and it is next to impossible to discover where they are located. This, then, describes the method of casting bronze statues in sand which is in general use.

The Lost Wax Process

There is another process known as the "Lost Wax Process," which it is said is one of the oldest methods of making statues, and which is also practiced in a modified form for certain classes of work at the present time. The object of the lost wax process is to give the artist something to retouch just previous to the pouring of the metal, and also to avoid the small fins at the core partings.

To do this the mold is made up in practically the same way as already described for the sand process, and the usual French molding sand is used. The cores are all put in, including the main inside core, and then melted beeswax, instead of metal, is poured into the mold, giving a figure, the core of which is made of sand and the surface of beeswax. The artist may then go over the beeswax surface, removing

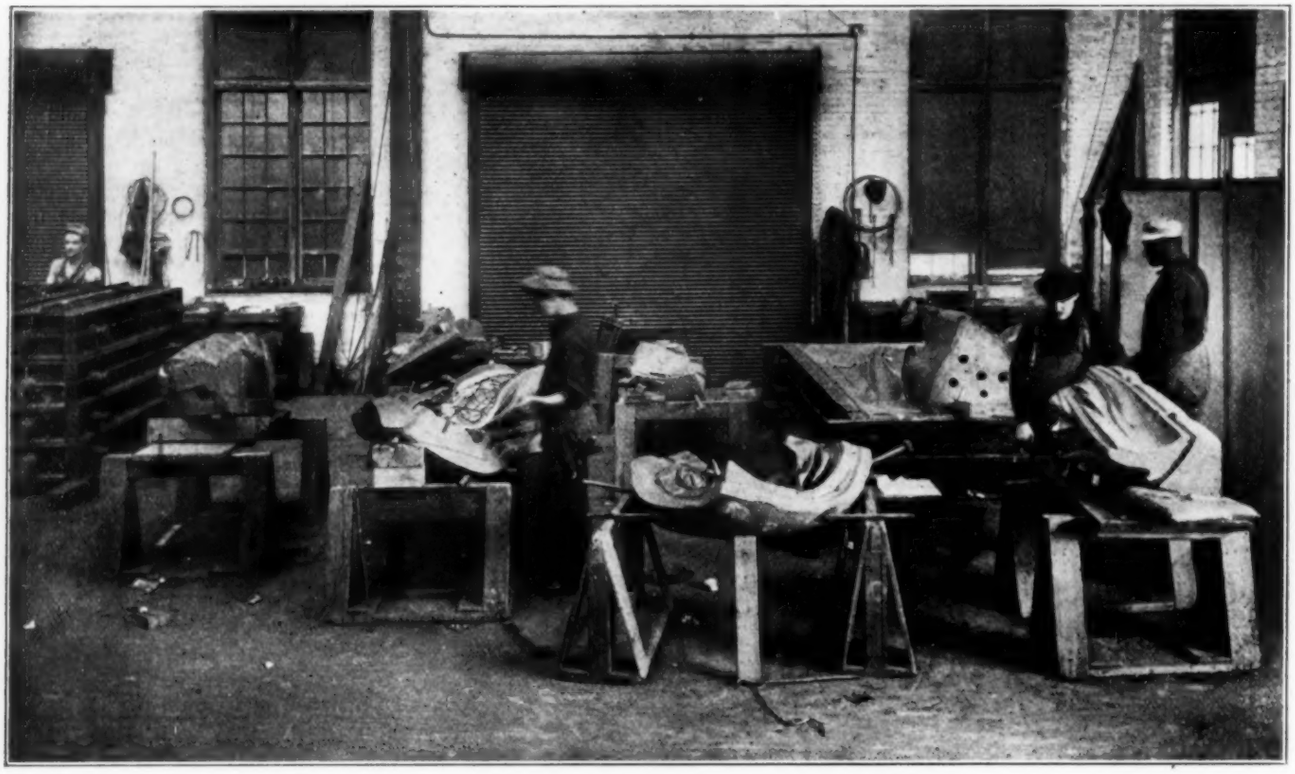


FIG. 4. INTRICATE CORE WORK MADE WITHOUT CORE BOXES

the fins and changing the details to bring out the effects desired as much as he may see fit.

When this has been done the outside molds are thrown away, including all their little loose cores, and the wax figure, with its sand core, is rammed up into a new sand mold, which will, of course, take exactly the form of the wax figure, and in this stage of the process none of the little loose sand cores are used, as the sand of the main mold fills in all the depressions and undercuts.

The question now arises, if there are no little loose cores, how do they get the mold apart to remove the wax pattern without spoiling the mold? The way to do this is to put the whole mold, with its core and the wax figure into the oven and bake it for a long time at a high temperature. This naturally melts out the wax, which runs down out of the mold, leaving the sand in place, and when the bronze is poured into this mold, the surface of the statue resulting will be just exactly what the artist produced when he went over the wax figure. Also there will be a complete absence of all the small fins, which are necessarily left by the many little loose cores of the ordinary sand process. It should be remarked, however, that these little fins are very easily chipped and filed away, and when the statue is finished they do not show at all.

While this wax process is supposed to give a very fine surface to the statue, it is claimed by the manufacturers that they can do just about as well with the ordinary sand mold and its little removable cores as can be done with the "Lost Wax Process," and at the same time do it much cheaper. This process is not used to any great extent, except as already said for certain classes of very fine work and even here its usefulness is doubtful.

The Washed-clay Process

All of this discussion has dealt with figures, but as, is well known, there is another form of bronze work, such as medallions, tablets, etc., containing sometimes a raised scroll work, but very often a relief of the human figure. The patterns in this case also are usually of plaster, and if there are any undercut parts, they are taken care of by the little loose cores, as already described.

If the backs of these tablets are examined it will be found that the surface corresponds more or less with the front surface and that the metal is nearly of a uniform thickness all over. To do this with a pattern having only one face and that the finished side, the mold of the front side is made, usually in plaster. Then all the depressions of the plaster mold are filled in with a thin layer of clay, this layer of clay being as thick as the thickness of metal desired.

When the depressions have thus been made shallower by the amount of the thickness of the clay, the other half of the mold is poured over in plaster, filling all the depressions down to the clay surface. Then by lifting off the new plaster half of the mold and removing the clay, it will be found that there is a complete mold formed which will give a thickness of metal exactly equal to the thickness of the clay. The clay is removed by washing, and this process is known as the washed-clay process.

In all of this work the halves of the molds are held in place by shallow mortise-and-tenon joints in the sand of the sand molds and in the plaster of the plaster molds because the registering of the two halves of the mold must be of far greater accuracy than can be produced by the ordinary flask dowel pins. Venting is taken care of much the same as with iron, except that there is very little gas to be carried off and there are no coke beds or cores used. The main core is usually vented in one or two places by the insertion of perforated piping leading to the outside.

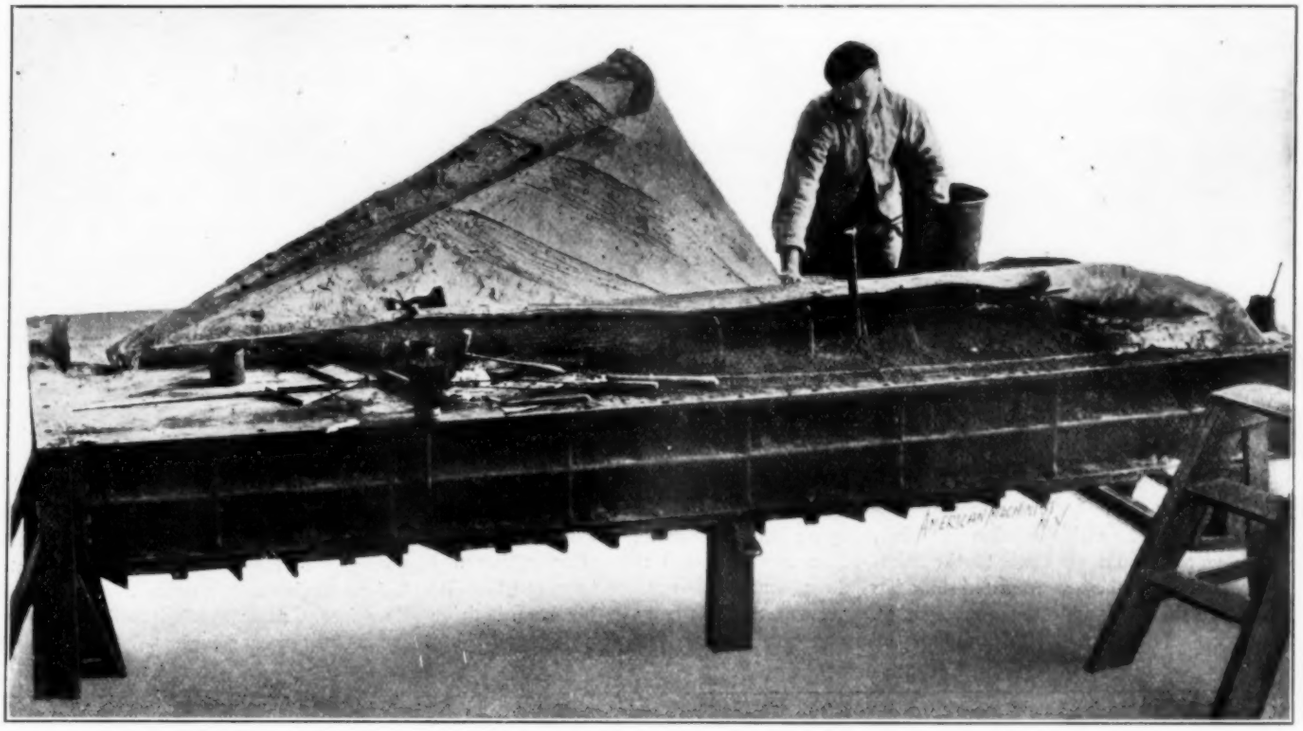


FIG. 5. THE FIRST OPERATION: BUILDING THE SAND AROUND THE PLASTER PATTERN

Spindle Boring

The Springfield Machine Tool Company, Springfield, Ohio, has been making some interesting tests of its No. 1 spindle and axle-boring machine in putting holes through a lot of 55- to 60-point carbon-steel spindles.

With a 1 1/16-inch drill a rate of 55 inches per hour was secured, while with a 1 5/16-inch drill, this was increased to 90 inches per hour, continuous boring. On short spurts a rate of 116 inches an hour was maintained for five minutes. With a 2½-inch drill a continuous rate of 37½ inches per hour was maintained. These were done with two-lip straight-fluted drills, having an inserted blade at the end and being stepped on the cutting edge to break up the chips. They were supplied with oil under pressure, at the point of the drill, to keep the chips cleaned away.

These drills have been adopted after

continued experimenting with the gun drill, two- and three-lip twist-drill points and other forms, and the results are certainly to be commended both for the machine and the drill itself.

The apparent discrepancy between the feed of the 1 1/16 and 1 5/16 is due to the fact that the boring machine was running full speed and could not be increased for the smaller size. The larger drill, being stronger to resist torsion, could stand a heavier feed per revolution than the smaller one.

Mold for Soft Metal Hammers with Iron Pipe Handles

By C. E. Chamberlin

Previous to making the double soft-metal hammer mold described and shown herewith, we had a single mold in which the eye for the handle was cast and subsequently fitted with wooden handles, which were broken off close to the hammer as fast as they were fitted in. To overcome this, we made the double mold, shown in Figs. 1, 2 and 3, and had the man on the pipe cutter cut all the scrap ¾-inch iron, gas and water pipe into 16- and 18-inch lengths (see *A*, Fig. 2), drilled a ¼-inch hole through them about 1 inch from the end and drove a piece of round iron *B* into it to prevent the hammer from flying off the handle. In trying out the hammer we found that after it flattened down somewhat it crushed the handle. To prevent this we had the blacksmith drive a piece of round iron *C* into the end about 2½ or 3 inches long. Since then we have had no trouble. After the hammers are worn out they are returned to the tool room and exchanged for new ones. The old hammers are melted off, when the handles are again ready for a new head.

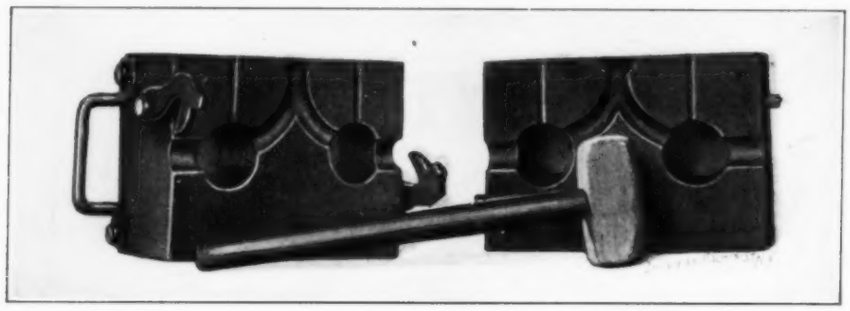


FIG. 1. THE MOLD AND A HAMMER

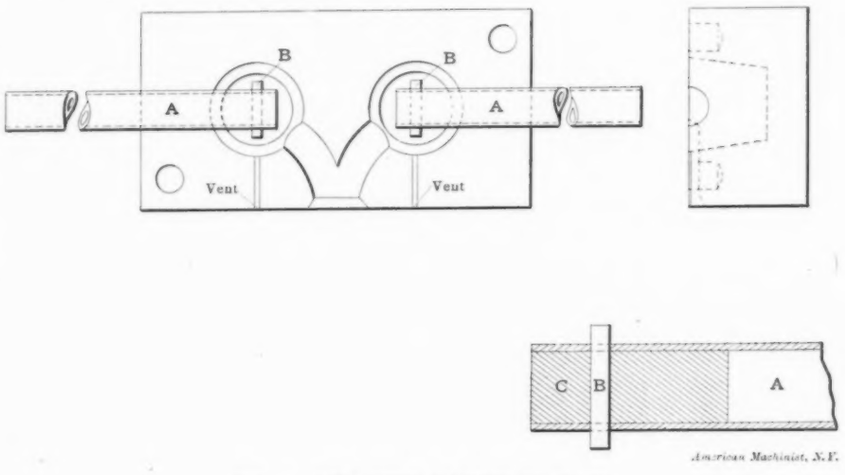


FIG. 2. MOLD WITH HANDLES IN PLACE

The mold, shown in Fig. 3, was made from two pieces of cast iron found on the scrap heap. The top and bottom faces were trued up on the planer, after which it was laid out, clamped out on the face plate of a lathe and bored, fitted with dowel pins, clamped together for drilling the runner, vent and handle holes. The runner was drilled part way and the balance chipped. The holes for the hammer handles were drilled, so that when the mold was clamped together it would pinch and hold them in position when pouring.

The composition of the hammer can be made to suit all conditions. We use half lead and half babbitt. The weight of the hammer with handle is from 7½ to 8 pounds. If the mold is warmed slightly before beginning to pour, the metal will flow freely, after which it will keep warm from constant pouring.

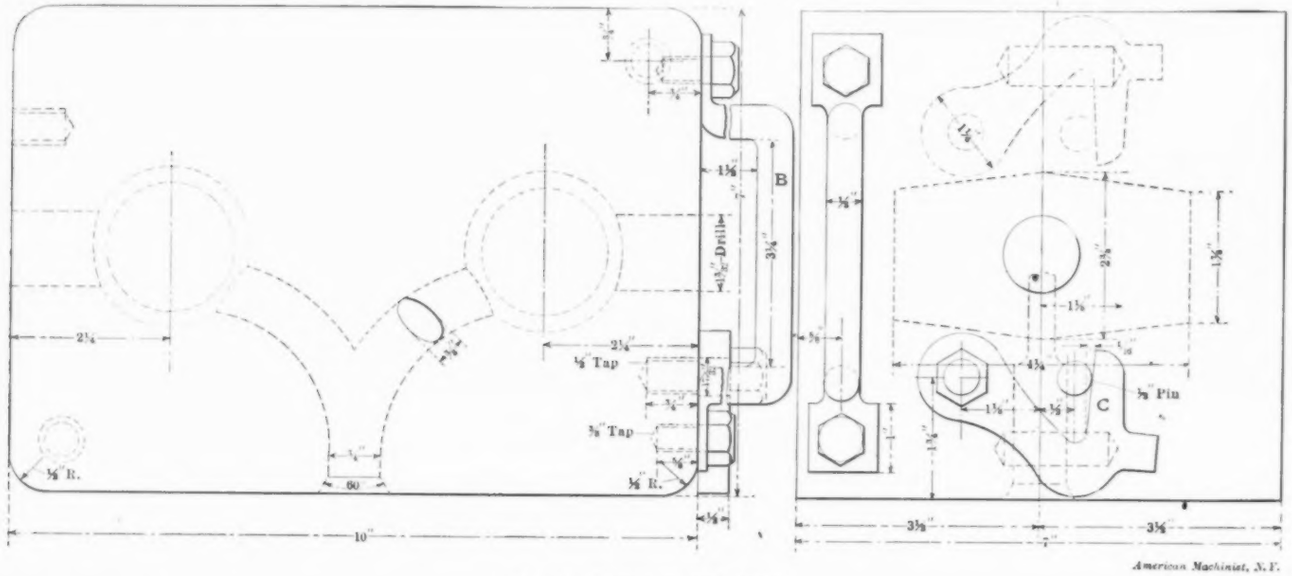


FIG. 3. DETAILS OF THE MOLD

Universal Drafting Machines of New Design

These Are Now Manufactured with Ball Bearing Joints and Tubular Rods, Giving a Light and Rigid Construction with Sensitive Action

SPECIAL CORRESPONDENCE

The Universal drafting machine, as readers of the AMERICAN MACHINIST are aware, combines in a simple unit a graduated scale, a protractor controlling the angular position of the square and a swinging arm which gives the square an accurate alinement and a direct sensitive movement so that either zero on the graduated square may be placed instantly at any desired point on the drawing. The development of this machine by the manufacturers, the Universal Drafting Machine Company, Cleveland, O., has resulted in the use of ball bearings, electrically welded tubular rods, readable metal scales, a new form of machine anchored near the middle of the board, counterpoised machines and various refinements; the accompanying halftones illustrating the principal features of the improved machines clearly.

In Fig. 1 is shown the machine as constructed with ball bearings, tubular rods and mid-anchor, a longitudinal section through one of the rods and bearings being shown in Fig. 3. In the ball joints the balls work tightly and with practically no friction, in hardened ground and polished races. The joints are rigid, arranged to take stresses in any direction and are provided with means of adjustment for wear. The end members of the rods are electrically welded to an elliptical tube comprising the main part of the rod proper so that while the rods are hollow and light, each is practically one solid piece possessing ample rigidity. The ends of the rods next to the anchor are swaged so that they have a larger section and the bearings at the anchor are much larger than the other bearings. The rods are finished in a durable enamel, satin finish. The ball bearings and tubular rods, of course, form a light, yet rigid construction, which is sensitive in its action. As illustrated in Fig. 1, the mid-anchor form of machine requires almost no room at the end of the board and is, therefore, particularly suitable for use where it is necessary to work close to a window, or an aisle where space is limited. Where required, an extension arm may be obtained for use in connection with this machine so that larger drawings may be made than are usually required. This arm is placed between the protractor and crossbar.

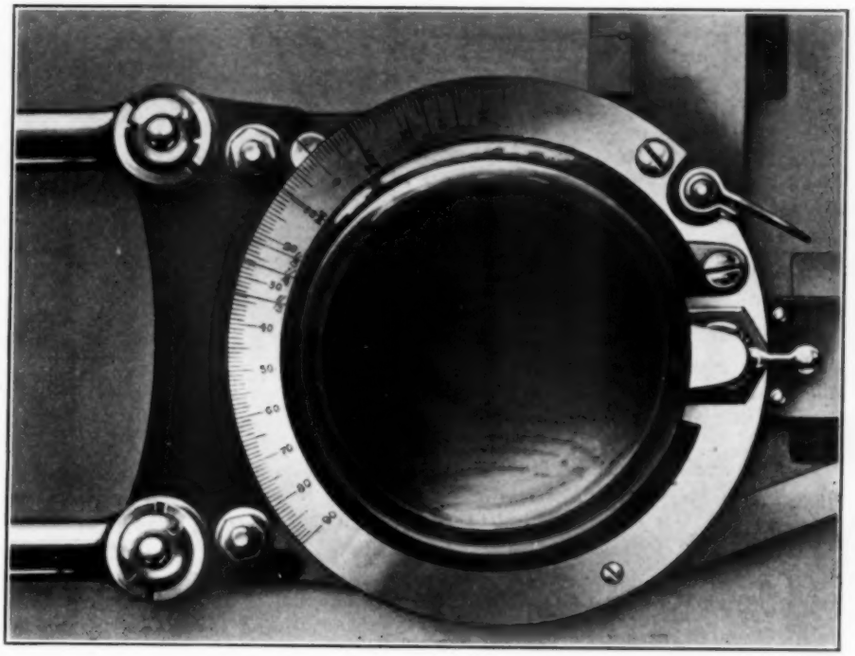


FIG. 2. PROTRACTOR

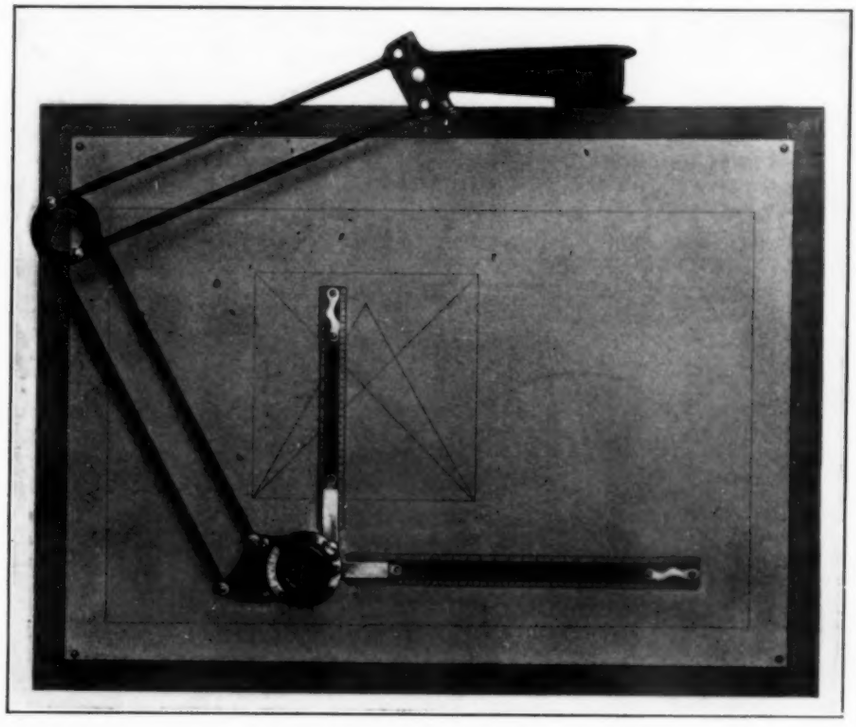


FIG. 1. UNIVERSAL DRAFTING MACHINE WITH BALL BEARING JOINTS, TUBULAR RODS AND MID ANCHOR

Protractors are made for this machine for various lines of work, including mechanical, structural, architectural and plotting work. The protractors are interchangeable, the standard protractor being 4 inches in diameter, graduated to degrees and numbered every 10 degrees. It is made of german silver. It turns 90 degrees to the right and 45 degrees to the left. It gives every angle in one position, half of the angles in two positions, so that the most convenient may be used. It is arranged to be clamped at any angle by

means of a small lever which may be seen at the right-hand side in Fig. 2. This lever is adjustable so that it may be used in the most convenient position. An automatic lock pin is also provided for instantly obtaining a setting at zero, or 30-, 45-, 60- and 90-degree angles. This pin is lifted by a quick side movement operating through a cam. When thrown toward the vertical scale, the lock pin operates automatically. When moved in the opposite direction, it is locked out of commission. The bushings in which the lock pin and center post move are provided with simple means of adjustment. It should be noted that the protractor shown in Fig. 2 is not graduated precisely like the one regularly used for mechanical drawing; this protractor, as shown, having a few additional graduations giving ⅛, ¼ and ⅓ roof pitches and 2 inches to the foot slopes each way from zero and being, therefore, especially adapted for architectural and structural work. In all other respects, however, it is identical with the regular protractor for mechanical work.

A counterpoised machine is illustrated in Fig. 4. This machine has been developed especially for use on vertical boards and, as will be seen, all that has been added to it is a set of spiral springs with connecting parts properly arranged. The

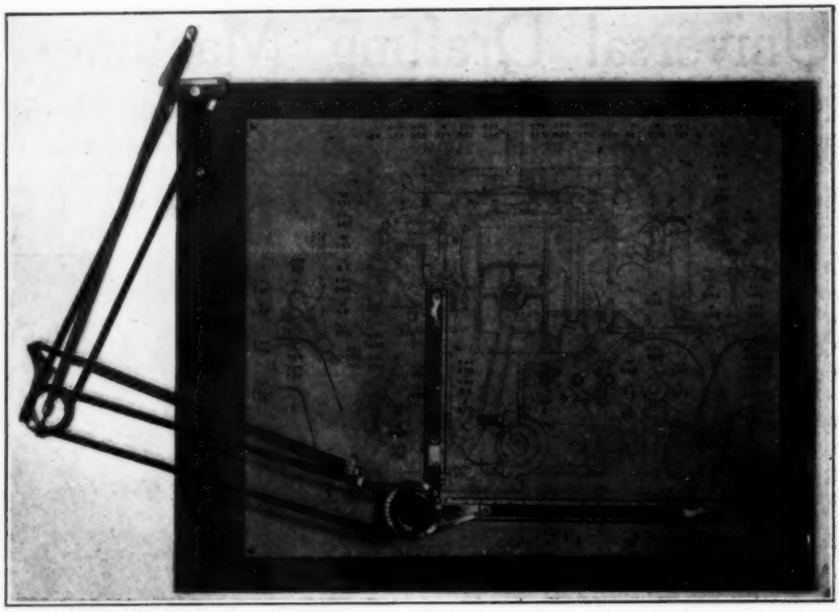


FIG. 4. UNIVERSAL DRAFTING MACHINE COUNTERPOISED FOR VERTICAL BOARD

FIG. 3. CONSTRUCTION OF BEARING AND ROD

counterweighted machine has a smooth and easy action and its advantages will be obvious to users of vertical drawing boards. A form of this machine adapted to school blackboards is shown in Fig. 5. This has been developed primarily for use in universities, technical schools, manual training schools, etc., for blackboard illustration in teaching geometry, trigonometry, mechanics and drawing. It is also adaptable to commercial uses and for engineering societies. As illustrated, it is suspended from a carrier which travels the full length of the board upon a rail that is attached to the molding at the top. It is so constructed as not to rub against the board when being moved and is provided with thick scales for crayon work.

While the machine illustrated in Fig. 1 is shown with a mid-anchor, corner anchors are also made for this machine as well as mid-anchors for the counterpoised type, which, in Fig. 4, is shown suspended from a corner anchor. Both mid- and corner anchors are constructed in various forms to suit the convenience of different users. Both boxwood and white-pine scales with white edges are made for these instruments and a new metal scale has been developed which is light in weight and presents a very small surface to the paper. It is made on a german silver base with a whitened nickel finish without luster. The scales, like the protractors, are interchangeable.

While the illustrations presented show the tubular frame and ball-bearing type of machines, the Universal drafting machines are also made with solid rods and joints formed of straight cylindrical pins, hardened, ground and polished, working in hardened, ground and polished bearings. As is the case with the more recent design of machines, the solid-rod type is also adapted for use with either corner or mid-anchors.

Another form of machine which may be referred to is known as the Junior drafting machine which, while not intended for use in the drawing office, forms a convenient device for making small drawings at the desk, in the shop, or at home.

The National Bureau of Standards in the Department of Commerce and Labor has contracted with A. H. Emery, who built the large testing machine at the Watertown arsenal, to furnish a new testing machine, to cost $150,000, for the use of the Bureau of Standards. This machine will be installed for the purpose of making tests for the public and for the other departments of the Government, the work of the Bureau of Ordnance in the War Department being now limited to the testing of materials for guns and gun carriages.

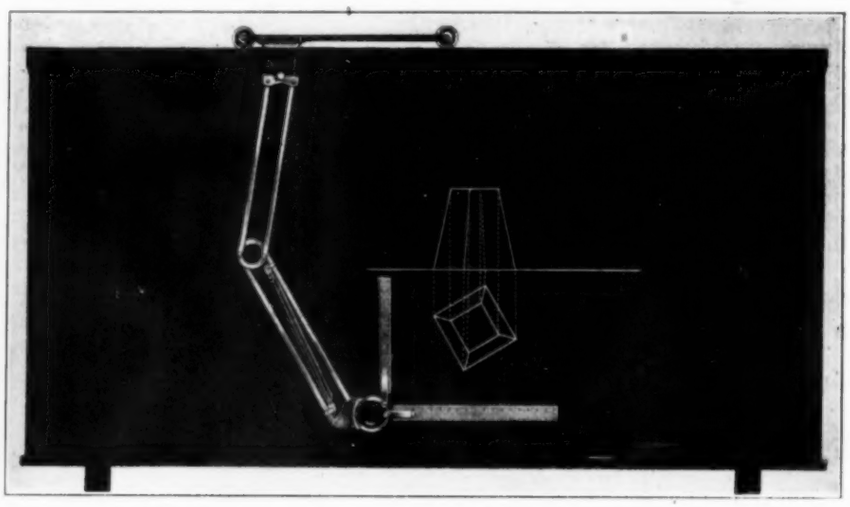


FIG. 5. UNIVERSAL DRAFTING MACHINE FOR THE BLACKBOARD

A Special Oil Groove Broach

By H. W. Gramley

The illustrations show a simple method of cutting three spiral oil grooves in bronze bushings, Fig. 1, which were ordered in large quantities.

The bushings were approximately 2 inches long, ½ inch bore and ⅛ inch wall, the grooves being about 1/16 inch wide, 1/32 inch deep, spiral to advance about one-fourth of circumference of bore in the length of the bushing. A broach was made about as shown in Fig. 2.

The overall length of the broach was about the same as the bushing, the ends entered the bore of the bushing without shake, while the cutting edge of each tooth (three in number) was located about 1 inch from the entering end *A*, and of course, approximated the desired section of the grooves.

The teeth were about ⅜ inch long, of the same angular pitch as the grooves to be cut, and their width slightly reduced

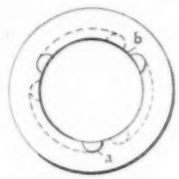


FIG. 1

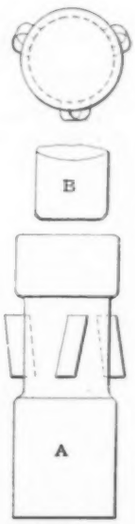


FIG. 2

American Machinist, N.Y.

THE WORK AND THE BROACH

toward the upper end on the side opposite the guiding edge. Room for chips was milled in the body and between the teeth, and this little broach when forced through the bushing made three spiral grooves which left very little to be desired in the way of excellence.

A small power press was equipped with a suitably counterbored plate for holding the bushing during the operation, and a push pin *B* was attached to the ram which, by its descent, pushed the broach entirely through the hole, giving excellent results as to speed.

Speed of Spur Gears

By Chas. H. Logue

When the question is asked, "what is the greatest circumferential speed at which a spur gear may operate?" we are told, "when 1200 feet per minute is exceeded either rawhide or herringbone gears must be used, and even when properly mounted 3000 feet is the limit of speed for any gear."

To illustrate the fallacy of this statement consider a pair of spur pinions, each

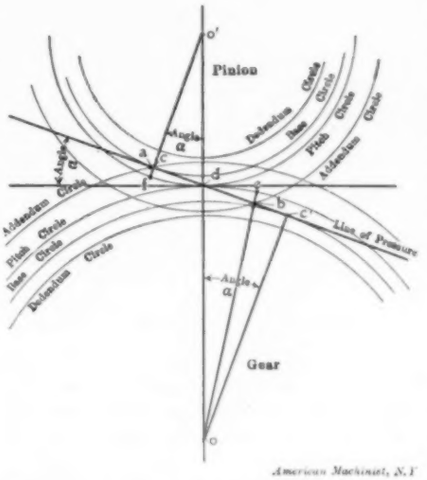


FIG. 1. DIAGRAM ILLUSTRATING METHOD OF DETERMINING NUMBER OF TEETH IN CONTACT

of 12 teeth, 6 pitch, 2-inch pitch diameter, running at a speed of 1200 feet per minute. A moment's consideration will show that the noise generated by such a drive would be excessive, as this would mean 2280 revolutions per minute. These gears would make their presence known at a speed of 400 feet per minute, which represents 761 revolutions per minute.

At first thought it appears that the number of teeth in contact would represent the comparative speed value, but, as it is sometimes possible to obtain as many teeth in contact in a small pair of gears as in a large pair, owing to the difference in pitch, the proportion of gear diameter must also be taken into account. The proportionate value of the gear diameter is represented by the number of teeth in contact, the pitch remaining constant. Therefore, this value may be gaged according to the circular pitch. Fig. 1 will illustrate this.

The relative speed value is found in the product of the number of teeth in contact and the circular pitch, or $n\,p'$.

n = Number of teeth in contact,
p' = Circular pitch.

The next step is the determination of a factor from actual practice, ρ, which, multiplied by the product of the value p' and the number of teeth in contact, n will give the safe speed. The formula now becomes:

$$Safe\ speed = p'\ n\ \rho. \qquad (1)$$

The factor ρ may be made to cover almost any type of gear or condition of service. If the safe speed is known for certain machine construction, the value of the factor ρ may be determined as below for similar drives.

$$Value\ of\ \rho = \frac{Safe\ speed}{p'\ n}. \qquad (2)$$

For general use the values of ρ have been estimated as in Table 1.

Herringbone gears, 45-degree angle of spiral	1300
Herringbone gears, 30-degree angle of spiral	1200
Herringbone gears, 20-degree angle of spiral	1100
Herringbone gears, 10-degree angle of spiral	1000
Spur gears, rawhide	1000
Spur gears, fiber	890
Spur gears, stepped teeth	820
Spur gears from exact cutters	800
Spur gears, commercial cut	670
Spur gears, machine molded	110 to 450
Spur gears, cast from pattern	0 to 225

TABLE 1. VALUES OF FACTOR ρ

Number of Teeth in Contact

As the necessary formula to determine the number of teeth in contact is considered too cumbersome for practical use, a graphical solution is given, as follows:

Referring to Fig. 1 the length of contact is measured between the intersection points of the line of pressure and the addendum circles of the gear and pinion, or between *a* and *b*. In case this intersection falls outside the intersection of a line drawn at right angles with the pressure line to the center of the gear as at the point *c*, the contact is measured from the point *c*, as this indicates that the distance *a c* must be deducted for interference. The gear tooth is rounded from this point out, or the flank of the pinion tooth is undercut to accomplish the same purpose.

If, on the other hand this point falls outside the intersection of the pressure line and the addendum circle as at *c'* this extra length must be deducted, as there is no contact until the point of the mating tooth has passed the addendum circle. In order that the number of teeth in contact can be stepped off, the lines *o' c* and *o b* are extended to the pitch line or to points *e* and *f*. The length of contact is then measured from *e* to *d* on the gear, and from *d* to *f* on the pinion along this pitch circumference. This distance divided by the circular pitch equals the number of teeth in contact.

Limiting Speeds

I estimate the maximum speed *to avoid danger of fracture* for the best type of gear and condition of service is 500 feet per minute per 1000 pounds safe working stress of the material of which the gear is constructed. Thus the maximum speeds would be as shown in Table 2:

4,000 feet per minute for cast iron pounds per square inch.	@ 8,000
8,000 feet per minute for cast steel pounds per square inch.	@ 16,000
10,000 feet per min. for machinery steel pounds per square inch.	@ 25,000

TABLE 2. MAXIMUM SPEEDS FOR GEARS.

To attain anything like these speeds, however, the gears must be exceptionally accurate and well balanced, also the housings must be sufficiently heavy to obviate practically all vibration. The restriction placed by the values of p' and n, however, will avoid the possibility of allowing the higher speeds. According to a series of experiments made by Prof. Charles H. Benjamin, AMERICAN MACHINIST, December 28, 1901, page 1421, the bursting speed of a solid, cast-iron gear blank is found to be 24,000 feet per minute. The centrifugal tension at this speed is 15,600 pounds per square inch. The same wheel, split between the arms, burst at an average speed of 11,500 feet per minute.

In this connection I have knowledge of a pair of herringbone gears, cast iron and machine steel, 80 and 24 teeth, 6 normal pitch, 20- and 6-inch pitch diameters, angle of spiral 45 degrees that are practically noiseless at a speed of 3150 feet per minute. At this speed, however, the load is comparatively light. These gears are driven by a 10-horsepower motor and are entirely satisfactory.

CONSTRUCTION OF THE GEAR

Approximate multipliers given in Table 3 should be used for various designs in reference to limiting speeds.

Properly proportioned solid gear	1.00
Gear split through the arms	0.75
Gear split between the arms	0.50
Link flywheel construction	0.60

TABLE 3. APPROXIMATE MULTIPLIERS FOR VARIOUS GEAR CONSTRUCTION.

These values correspond closely to those given by the Fidelity and Casualty Company, which sets the limit of speed for a solid flywheel (cast iron) at 6000 feet per minute. No value is given for the wheel split through the arms.

The principal cause of failure (as pointed out by Professor Benjamin in the article above referred to) in gears split between the arms is the necessity of placing bolting lugs on the inside of the rim. These lugs naturally tend to increase the stress at their point of location and fracture the rim in this locality at correspondingly low speeds.

LOCATION OF THE GEAR

The influence of the location on the speed cannot be well classified. In general, however, for gears mounted upon insecure foundations or secured to the wall or ceiling of light buildings more or less allowance must be made. One case in mind is a 10-horsepower motor direct-connected to a line shaft making 150 revolutions per minute. The motor is securely bolted to the joists; the gears have 106 and 22 teeth, respectively, 4 diametral pitch, 5-inch face, cast iron and rawhide; the speed is 1050 feet per minute. These gears were exceptionally noisy and were replaced by herringbone gears of the same normal pitch, with the angle of spirality 20 degrees. The gear in this instance was cast iron and the pinion machinery steel. These gears were no better than the first pair and were replaced by gears with a spiral angle of 45 degrees. These proved to be but little better, and as a last resort a pair was installed with an angle of 76 degrees. These gears were fairly quiet when operating under full load, but very distressing when running light. This condition is sometimes found in spur gears with excessive back lash. It was noticed that the teeth gave evidence of rapid wear due to the reduced face contact. Rubber cushions placed under the motor and shaft hangers and filling the space between the hub and rim with wood made no perceptible difference in the noise of this drive, which was finally abolished.

RELATION OF PRESSURE TO SPEED

The question naturally arises, "in what way does the tooth pressure influence the speed of gears?" From a power standpoint this is ordinarily taken care of by Mr. Barth's expression $\frac{600}{600+V}$. But this does not fix the speed at which noise may be avoided, which is the subject of this paper.

It has been assumed that the tooth pressure allowable at the speeds given by the formula (1) are within the limits placed by the formula for *wear*, published in the AMERICAN MACHINIST, Vol. 31, Part 1, page 95, and Part 2, page 114.

FACE CONTACT

For helical and herringbone gears I beg to submit the following formula for the determination of the length of face contact:

$$\text{Face contact} = \cos.^3 \text{of spiral angle} \left\{ \frac{\text{face}}{\frac{\text{lineal}}{\text{pitch}}} \right. \quad (3)$$

$$\text{Lineal pitch} = \frac{\text{lead}}{\text{number of teeth}}.$$

The value $\frac{\text{face}}{\text{lineal pitch}}$ cannot be carried lower than 1 as there cannot be less than one point of contact. As pointed out in a previous paper, "the *strength* of teeth in herringbone gears need hardly be considered as it is impossible to break out a single tooth provided the angle be great enough to engage another tooth before the first lets go." However, the face contact according to the above formula should be used instead of the actual face when determining the load for wear; thus increasing the angle decreases the noise, but increases the wear.

ILLUSTRATIVE EXAMPLE

Required the safe speed of a pair of solid steel spur gears of the following dimensions:

Gear, 80 teeth, 2-inch pitch, 6-inch face, 50.93-inch pitch diameter, pinion, 48 teeth, 2-inch pitch, 6-inch face, 30.558-inch pitch diameter.

Cutters for these gears to be made for the exact number of teeth.

The computations for speed involve the number of teeth in contact = 2.5, value of ρ according to Table 1 = 800, safe speed $= p' \; n \; \rho = 2 \times 2\frac{1}{2} \times 800 = 4000$ feet per minute. According to Table 2 these gears would be amply safe to resist fracture at this speed, but would be at the extreme limit for cast iron of a safe stress of 8000 pounds per square inch. The computations for wear involve, assuming that the pinion is made from steel of an elastic limit of 50,000 pounds per square inch, the limiting tooth pressure at this speed would be equal to the value W^e as follows:,

$$W^e = c \, f \, A \frac{600}{600+V} =$$

$$2.4 \times 6 \times 3000 \times 0.13 = 5600 \text{ pounds.}$$

In which,

$c = 2.4$,
$f = 6$,
$A = 3000$,

and

$$\frac{600}{600+V} = 0.13.$$

The computations for strength involve the use of the Lewis formula, based on carrying the entire load on one tooth,

$$W = s \, p' \, f \, y \frac{600}{600+V} =$$

$$25{,}000 \times 2 \times 6 \times 0.111 \times 0.13 = 4600 \text{ pounds.}$$

In which,

$s = 25{,}000$ pounds per square inch (one-half the elastic limit),
$p' = 2$ inches,
$f = 6$ inches

and

$y = 0.111$ for 48 teeth.

As the load should not exceed the strength of the tooth this pressure is the limit to be used. The corresponding horsepower transmitted would equal,

$$\text{Horse-power} = \frac{W \, V}{33{,}000} =$$

$$\frac{4600 \times 4000}{33{,}000} = 557 \text{ horse-power.}$$

These gears if properly mounted should be satisfactory at a speed of 4000 feet per minute. The value ω^e indicating that they could be used for 10 hours per day service for two and one-quarter years at a uniform pressure of 4600 pounds. If longer life or service per day is required the load on the tooth must be reduced accordingly.

Among the Machine Tool Builders

EDITORIAL CORRESPONDENCE

There is a decided state of unrest in the designing end of the machine-tool business just at this time over the question of gear boxes for both speeds and feeds. Any man with sporting blood can get bets on either side without the slightest difficulty and time alone can decide the winner. Gears still have the call in most cases on milling machines and lathes of large capacity but some who are building them are wondering whether they haven't pushed the case too far and are almost ready to hedge in favor of the belt drive.

On feeds, particularly on lathes, while some builders have received orders for belt feeds (not the old one-inch belt, however) to replace geared feed lathes, the general feeling is that they have come to stay, but that they will be modified in many cases so that, instead of having 176 feeds (or some other unheard of number) at instant command, they will have from three to six feeds in a simple box that can be cheaply made and that does not have gears enough to start a store with.

When it comes to gear drives themselves or what is known as the single-pulley machine, there is more difference of opinion than on feeds. Some contend that for the heaviest work, gear boxes are needed in both places, while others claim that even on the heaviest work a properly designed belt drive is the more satisfactory.

Nearly all argue, however, that we have gone to extremes in many cases and that many gear-driven machines have been bought when a belted machine would have been cheaper and equally good for the work to be done. Some buyers insist on a geared machine because they think it is more up-to-date, rather than because of its actual merit for their work and salesmen have been known to use similar arguments in selling.

POWER REQUIRED FOR FEEDS

Speaking of feeds, however, there is a little experiment which can be tried to advantage as an object lesson. Take any good sized lathe in the shop, say a 24-inch, put in a piece of work that will stand a heavy cut and set the tool for a heavy cut. Disconnect the feed rod so that it turns freely and then see how heavy a feed you can get by simply gripping the feed rod in your hand and turning it. The chances are that you can stall the lathe by simply feeding in this way, which indicates that not as much power is required for feed as we have generally supposed. Of course, it is geared up at a good ratio with a worm or otherwise, but the old feed belt has the same advantage and a bigger leverage. It's worth thinking over at any rate.

Milling-machine feeds require more power as a much larger surface is in contact with the milling cutter than the lathe tool, but belts are being considered and used even for these.

GEARS IN MACHINE TOOLS

The gear drives and the high-speed steel have made necessary a decided change in the gear practice of all machine-tool builders. Cast iron has given place to steel and in some cases to chrome-nickel steel the same as used in the automobile gear boxes, especially for high-speed gears, while the form of the teeth and the cutting of the gears are also receiving much attention.

Some shops do not use "range" cutters for their best gears but have special cutters made for the number and pitch of teeth. This gives a better running gear as a range cutter must of necessity, be a compromise so as to answer for all its range, without being exactly right for any of them. Then too, gears are being tested on arbors accurately placed at the correct center distances to detect errors of boring and cutting.

Pressure angles and tooth lengths are also being carefully considered, some sticking to the standard length 14½-degree tooth, others using the 20-degree stub tooth, some a 20-degree of standard length and in one case a 22-degree tooth, also of standard length.

Even pitch lines are no longer sacred and gears are being tried in which the pitch line has been ruthlessly torn from its time-honored position and moved out on the pinion and in the gear, as is frequently done in bevel gearing to meet the conditions of automobile driving at the rear axle. Then the ends of the teeth are being rounded instead of being left in their involute shape to afford easier entering where clash gears are used.

BORING WITHOUT JIGS

There are also interesting developments in the methods of machining holes in large castings such as shapers, milling machines and the like. We have had the jig or fixture habit for so long that we naturally build one for almost any piece we make in quantity, no matter what their size. But some shops have found a different side to the proposition. One case in particular is a good sized geared shaper where the various holes must be located the correct distance apart to insure quiet running of the gears.

Instead of boring these in a fixture they are bored on a horizontal machine of the type with a movable head and bar. The center or main hole is bored first, a locating bushing put in this hole while the head is being moved for the next cut, and this distance located by a feeler which is used in a remarkably short space of time.

The results are very accurate and the line of reasoning is along this line: The chance for play between the jig and the bushing, the play between the bushing and the bar running in it, which increases every time it is used, is greater than the error found in the other method. With a machine which can be quickly handled and accurately set the time is said to be nearly as quick as with jigs, any difference being made up by the interest saved on the investment that would be necessary.

This is not done with the idea that jigs are of no value, for they are used in some of the work on the same machine. It is a case where individual judgment has decided against jigs in this case, instead of using them as a matter of course.

It points out that there is no single rule which will prove best in all cases, but that each case should be judged on its merits instead of following beaten paths blindly. We are all too apt to think because a tool or a method is good in one or two places that it must be in all, but this is far from being the case. F. H. C.

A Hardening Compound

BY JOSEPH WEANER

In this advanced age of machinery when high-speed steels are used extensively, a proposition often confronts a mechanic to make a fine tool that will stand high speeds and feeds. When the question of hardening comes up a high heat is essential for hardening the tool; therefore, if the greatest kind of care is not used the tool will be burned and probably ruined. I have overcome this very successfully with the following, and thinking it would be interesting to the AMERICAN MACHINIST readers I have inclosed the way of accomplishing the feat:

Take 2 pounds of rye meal, 1 pound of common salt, ¼ pound of pulverized charcoal, ¼ pound of pulverized borax, ½ pound, or ⅓ of a pint, of liquid cyanide of potassium, ½ gill, or 2 ounces of water glass (silicate of soda) and 3 pints of water. The liquid cyanide is made by dissolving 3 ounces of pulverized pottassium cyanide in 1 pint of boiling water.

Mix these ingredients thoroughly to form a paste, heat the steel to a cherry red, roll it in the paste and dip it in a bath of either sperm, fish, or kerosene oil.

From a series of tests conducted on bessemer steel, mild steel, wrought iron and copper, in order to determine the effect of strain on the strength of ductile materials, the results of which were presented at a recent meeting of the Engineering and Scientific Association of Ireland, a conclusion reached, as far as the experiments had gone, which were limited owing to the comparatively small size of the testing machine used, was that any kind of strain raised the yield point and breaking strength and decreased the elongation for any kind of stress, but that the ultimate strength of the material was little affected by strain.

Snap Piston Rings and Their Making

The Making of Rings to Fit the Cylinders when New and Without Depending on Wear. A Scale of Successful Proportions for These Rings

BY F. A. HALSEY

The discussion which has been going on in these columns for some time relative to the making of snap piston rings, has led me to look up some of my old notes in order to give the dimensions together with the particulars of manufacture which were evolved during my shop days and which differ in some respects from the methods usually followed. The chief difference between these and the more usual methods lies in the fact that the gap was cut out of the ring before turning, and then closed by a clamp, after which the ring was turned to the true diameter of the cylinder. The chief advantage of this method is that it insures a fit between the cylinder bore and the ring, a further incidental advantage of which is that the gap may be made a good deal larger than is customary—a feature which permits the ring to be put in place over a solid piston with much less danger of breakage than with smaller gaps, especially in the smaller sizes of rings.

Laying Out the Pattern and Machining the Rings

In laying out the pattern the circumference of the finished ring was determined, and to it the width of the gap, Fig. 1, was added, the diameter due to the resulting circumference being then determined. To this a suitable allowance for finish was added, giving the outside diameter of the casting, the inside diameter being then laid out to give the thicknesses *a* and *b* without allowance for finish, as the inside of the rings was left rough. A rib was cast lengthwise of the sleeve on each side of the gap, as shown in the illustration, in order to provide for applying the clamp when closing the gap before turning.

In machining the rings the sleeve casting was mounted in the lathe and the rings faced to their finished width as cut off, leaving no further operations necessary, except the cutting out of the gap and the turning of the circumference. After cutting out the gap the clamp was applied to the lugs, closing the gap, the ring and clamp being then bolted to a face plate and the ring turned the true diameter of the cylinder bore.

Nicety of Dimensions Not Necessary

Fig. 2 gives the dimensions used, but with respect to these it should be said that, because of the uncertainties of foundry work, the casting will not always agree exactly with the intended figures. Moreover, by reason of the rings springing out of the circular shape when the gap is closed, ample allowance for finish should be provided. It may, for these reasons be found necessary to alter the pattern after the first casting is made, although lack of stock for finish may be met to a certain extent by reducing the size of the gap, and of the other dimensions there is no necessity for nicety.

The dimensions shown are not offered as necessarily better than others, but simply to give the proportions of rings of which large numbers were made with entire success. As a matter of fact, in some of my own cases, the castings did not exactly agree with the intentions, but it was not thought worth while to change the patterns on that account unless the discrepancy was unduly large. If the rings are laid out in accordance with the chart and the pattern is then carefully made, the resulting rings will, in all ordinary cases and without correction of the pattern, meet all requirements and that is all that any rings can do.

Of course, the removal of the skin of a casting under strain, as in the turning of these rings, will result in a slight departure of the ring from the circular form when it is released from the face plate. If the maker of the rings wants to be nice about it, this may be corrected by releasing the clamping bolts between the roughing and finishing cuts, although without this the rings will be a much better fit than when turned large and then sprung inward in the usual way, which seems to me so crude as to be intolerable.

Pressure of the Rings Against the Cylinder

Regarding the large increase in the width of gap shown there is nothing to be said against it, as the strength of such rings is not sufficient to bring about any undue pressure against the bore of the cylinder. The fact is that the rubbing of the rings against the cylinder wall introduces a sort of peening action and no matter what their original strength they soon lose most of it.

In this connection it should be said that the mathematical determinations which we see occasionally by which it is thought to determine the varying thickness of the ring in order that it may give uniform pressure throughout its length have always seemed to me to be beside the mark. If that were of importance this method of construction would secure it better than any mathematical determination, but there is no doubt that the force which presses the ring against the cylinder wall is chiefly the steam pressure, compared with which the force exerted by the strength of the ring is insignificant.

Action of the Rings Under Pressure

Referring to Fig. 3 in which the clearances are exaggerated for clearness, the steam comes down the joint between the piston and the cylinder bore from right to left and flowing down the joint *a b* establishes full pressure in that joint and below the ring. The steam also establishes a creeping film in the joint *a d*, beginning at full pressure at *a* and ending at such pressure at *d* as may exist at the left of *d*, the average pressure of the film being about the mean of the initial and the terminal pressures. Under these circumstances the outward pressure prevails and the ring is forced against the cylinder bore. The existence of this creeping film of steam was demonstrated by Prof. S. W. Robinson many years ago. That the action described is the real one is further shown by the tendency of these rings to wear the cylinders most at their ends where the pressure is heaviest. In this connection, too, it is doubtful if the eccentric construction has much value beyond satisfying the feeling that it is appropriate for the purpose.

A consideration of the action described in connection with Fig. 3 will show that the practice which some follow, of placing two rings in a groove is wrong. The average pressure per square inch of the surfaces in contact with the cylinder bore is substantially the same with two rings as with one, while the two rings, having twice the surface, exert twice the total pressure and double the tendency to wear the cylinder. On the other hand if the rings are placed in separate grooves the second one has only to deal with the pressure due to the leakage past the first, this step-by-step action explaining why a few such rings, placed in separate grooves, result in a piston which is practically bottle tight. The fact that two rings in the same groove may be so placed as to break joints has no value, as the action is precisely the same as that of the lapped joint referred to in the next paragraph.

Useless Features of Rings

Another feature of these rings, as sometimes made, which serves no purpose except to spend money uselessly is the lap joint, shown in Fig. 4. With such a joint the steam follows the course indicated by the arrow and escapes as freely as though

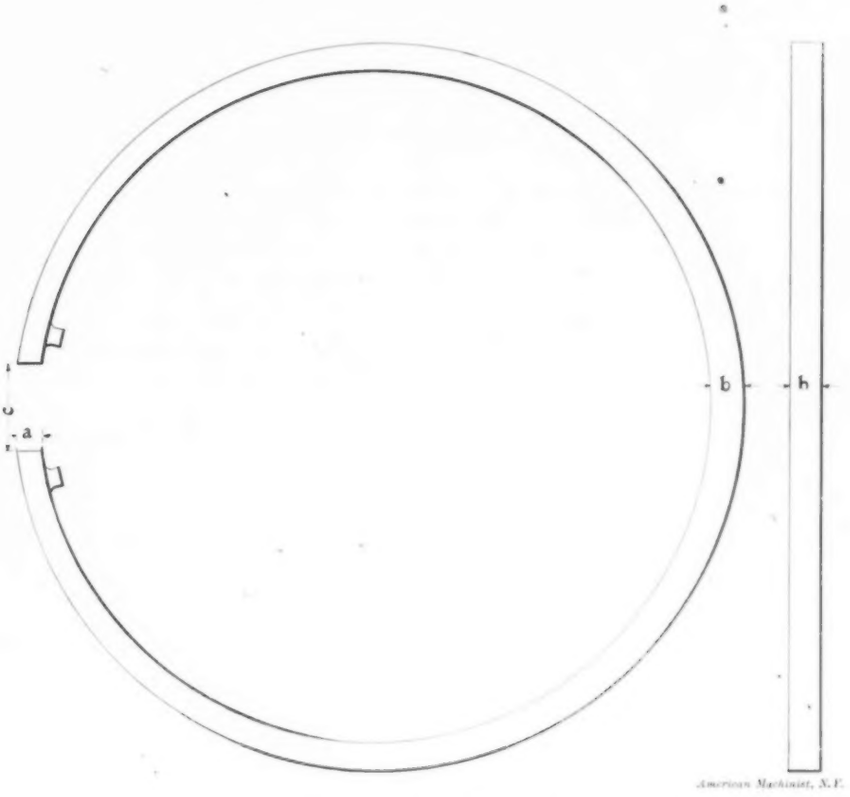


FIG. 1. A SNAP PISTON RING

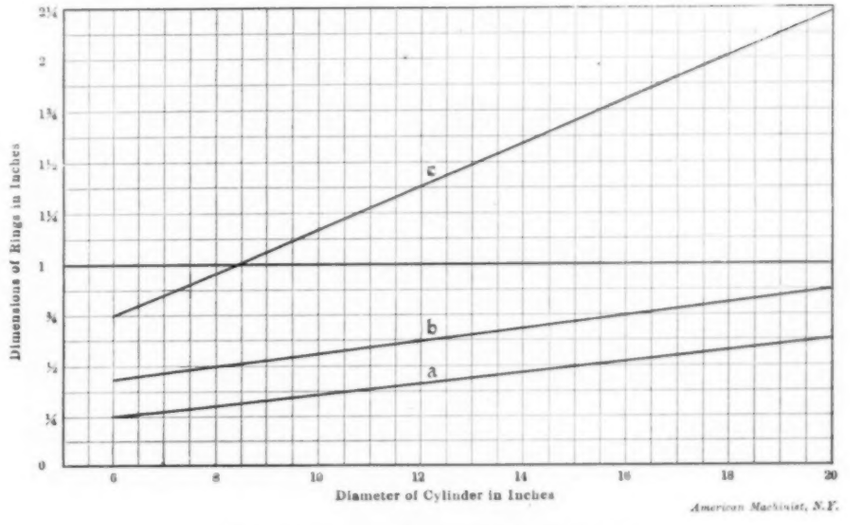


FIG. 2. DIMENSIONS OF SNAP PISTON RINGS

$a = 0.0268\,d + 0.0893$;
$b = 0.0312\,d + 0.25$;
$c = 0.1071\,d + 0.1071$;

d being the diameter of the cylinder and the remaining notation, as in Fig. 1. All dimensions in inches.

Chart and Formulas for Laying Out Snap Piston Rings

the lap were absent. The only good effect of this form of joint is to prevent the tendency to streak the cylinder, due to a plain square joint, but this can be obviated just as effectively by cutting the joint at an angle.

Another effective way of wasting money in piston construction is to make the rings a close and, in some cases, a scraped fit in the piston grooves. Long before he originated the phrase, Professor Sweet pointed out that this is one of the "things that are usually wrong," due to the fact that such close fits encourage the action of the oil residue in sticking the rings in their places. It is altogether probable that up to the point where noise

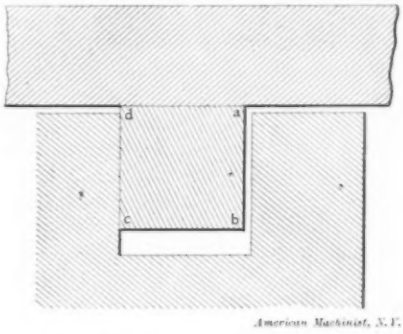


FIG. 3. ACTION OF A SNAP PISTON RING UNDER PRESSURE

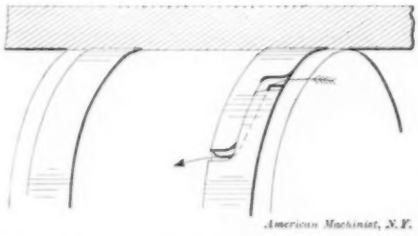


FIG. 4. STEAM BLOWING PAST A LAPPED JOINT

develops a little shake of the rings in their grooves is advantageous.

Eccentric rings being heaviest opposite the joint, they have a tendency, in horizontal cylinders, to work around to a position with the joint at the top of the piston, where the steam may blow through freely. To prevent this these joints should be placed at or near the bottom of the piston and pins be inserted in the grooves to keep them there.

In my own practice rings were made to the dimensions given on the chart of 8, 10, 12, 14 and 16 inches diameter, the chart being extended 2 inches downward and 4 inches upward beyond actual experience. Personally, I should not hesitate to carry it still farther upward should the need arise.

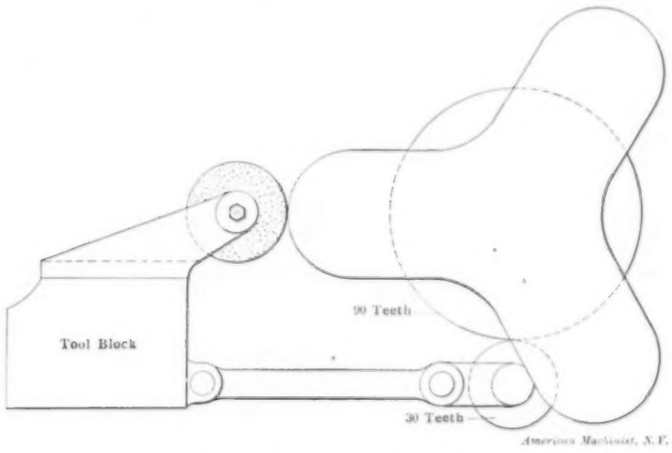
Formulas for Those Who Want Them

Those who prefer formulas to charts may get the same results from the following equations, in which d is the diameter of the cylinder, the remaining notation being the same as in the drawing of the ring, and all dimensions in inches:

$a = 0.0268\,d + 0.0893$;
$b = 0.0312\,d + 0.25$;
$c = 0.1071\,d + 0.1071$.

Grinding a Three-lobe Cam

An experimental machine required a three-lobe cam something like the one shown in the illustration, which had to be exact and this meant finishing by grinding, as it was out of the question to machine it in any other way. So a lathe was rigged with a tool-post grinder on the tool block, and this had to be moved back and forth at the proper time to reach the entire cam with the wheel shown.



GRINDING A THREE-LOBE CAM

Three-lobe cam made it necessary to have the wheel move in and out three times to every revolution of the lathe spindle carrying the cam. The face gear had 90 teeth, so a 30-tooth gear was mounted to mesh with it and drive the small crank shown, which moved the tool block and grinding wheel by the connecting rod, moving it in and out three times for every revolution of the cam or once for each lobe.

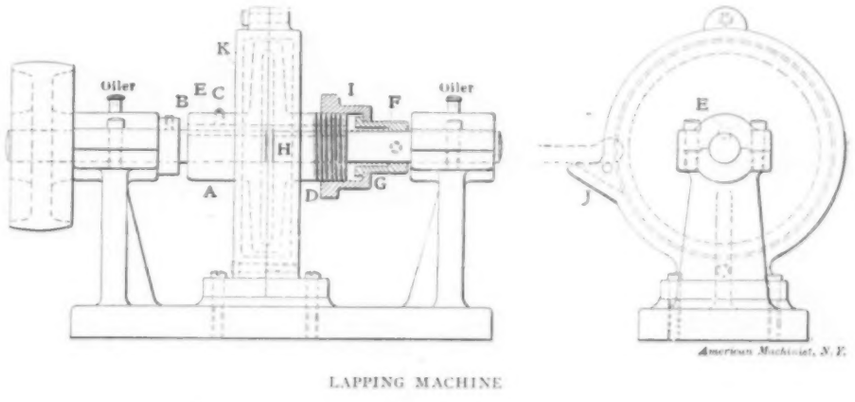
Of course, this will not grind a cam of just the shape shown, as can be readily seen by laying out the motion obtained from the crank and tracing the wheel contact with the cam to be ground. It shows a plan that may be used in different ways to grind or mill irregular shapes, and though not a new principle, is a simple application that can be easily made.

A Machine for Lapping Thin Flat Stock

By F. Ebel

The drawing shows this machine clearly. A cast-iron disk A is fastened to shaft B by set screw C and key E. The cast-iron disk D slides on the shaft B, but is caused to revolve with the shaft by the key E which passes through both disks.

A hardened collar F is fastened on shaft B and has a recess to receive the spring G; this spring forces the disk D forward and tends to close opening H between the two disks. The hardened sleeve I determines the opening H and can be adjusted as indicated. The work rests on the pin J, which is supported by the lugs formed on the case K. Emery and oil is put in case K, so that the disks are running in the mixture continually.



LAPPING MACHINE

Polishing Metals for Examination with the Microscope*

By Albert Kingsbury

In 1902 I made experiments to find the most suitable method of polishing samples of metals for microscopic examination. The polishing of the surface is one of the most important as well as most troublesome details of metallography, particularly when high magnification is required.

At the outset, trials were made of all the methods of which descriptions have been published. Some of those methods have been successfully employed by various metallographists, as shown by numerous reproductions of excellent microphotographs in different publications. Nevertheless I did not find any of these free from objectionable features. The ideal method should produce a fairly flat surface, free from excessive relief of the harder constituents, rounded edges at flaws, or scratches and smearing of the metal. The method should be simple, the materials employed readily available, and the process as rapid as consistent with the first-named requisites. None of the published methods embodied all these requisites, nor is a perfect method likely to be found. However, the method finally developed by me appears to be superior.

Preliminary Investigations

The preliminary trials were made with rotating disks covered with various materials, including canvas, felt, silk, leather, chamois, parchment, paper, wood, pitch, asphalt, resin, shellac, beeswax, etc. The polishing powders included commercial abrasives, such as emery, carborundum, tripoli, crocus and jewelers' rouge; also precipitates, such as carbonates and sulphates of the alkaline earths. Attempts were made to obtain fine finishing powders by the levigation process from commercial abrasives. These abrasives were tried both wet and dry and with various speeds of the disks. Hand polishing was also tried. It is needless to detail the objectionable features encountered, which are probably familiar to all metallographists.

The method finally adopted was the result of two distinct discoveries: (a) That ordinary paraffin wax makes a good polishing bed; (b) that excellent polishing powders of certain grades are commercially available.

The paraffin is used as a facing for rotating disks of metal, preferably brass, about 8 inches in diameter. The disks are grooved on the flat face for anchoring the wax. To prepare the disks, they are warmed to about 100 degrees Centigrade, and laid flat and then melted paraffin is poured on them to a depth of about ½ inch, a removable ring or band retaining the melted wax. The whole is then covered to exclude dust and allowed to cool. After the wax has solidified it may be dipped in water to hasten the hardening. Since the wax has very little viscosity when melted, all hard foreign particles, which might produce scratches in the samples, settle out before the wax hardens, the elimination being practically complete. No advantage in this respect was gained by keeping the wax in a fluid condition on the disk for several hours in an oven. After the hardening of the wax, the disks are placed on the spindle of the polishing machine and the face of the wax is turned true and flat by a hand tool.

In my machine the spindle was horizontal and four disks were used, for abrasives of progressive fineness, two disks being placed back to back at each end of the spindle. The disk used for the final polishing should not be perforated and the wax should be continuous to the center of the disk, as that part is best for the finishing touches to the sample. This latter disk should be at the right-hand end of the spindle. The speed of rotation should be about 200 revolutions per minute; a higher speed throws off the polishing powder with the water used, and a lower speed makes the work too slow. A stationary sheet-metal strip about 3 inches wide bent over the disks serves as a screen.

Polishing Powders in Order Used

The polishing powders, in the order used, were as follows: (a) Commercial flour of emery; (b) washed Naxos emery, 3/0 grade; (c) washed Naxos emery, 7/0 grade; (d) soft optical rouge, light grade. These were obtained from the George Zucker Company, New York, except the first, which is available everywhere.

The emery powders were mixed to a paste with water in tall glass jars provided with covers; the paste was applied to the rotating disks with small brushes as required, the brushes being kept in the jars when not in use. The rouge was in cake form, best applied by holding a small piece in the hand, wetting both the rouge and the wax, and pressing the rouge lightly against the rotating surface.

A small quantity of water is required throughout the polishing process, but water cannot be used very freely without wasting the powders. The water is best applied as required, from an ordinary chemist's wash-bottle, held in the left hand while the right hand manipulates the sample. No water pipes nor drains are required for the polishing machine. Distilled water may be used if available. If tap water is used, it should be drawn into large jars provided with covers and siphons, and allowed to stand a day or more before use, in order that all gritty particles in suspension may be deposited. The inner ends of the siphon tubes should be at least 3 inches above the bottom of the jars.

Treatment of Samples

The treatment of the samples is as follows: The samples are first dressed to shape and size by any convenient method, the surface to be polished made flat by an emery wheel or file, and the sharp edges rounded to prevent cutting into the wax. The dimensions of the samples should depend to some extent upon the coarseness of structure. For normal iron and steels, and for much other work, a ⅜-inch cube is a convenient sample. Massive castings sometimes have grains an inch or more in diameter, and correspondingly large samples are required. The samples are held flat against the waxed disks, which are kept well covered by the polishing paste, using successively the flour of emery, the 3/0 emery, the 7/0 emery, and the rouge, on the several disks. At each grinding with emery the sample should be held without rotation and with a slow transverse motion across the face of the disk until the grinding marks show over the entire surface. The sample may then be given a quarter turn, so that the new marks cross the old ones, and so on. The disks must be kept wet continually while grinding. With each grade of powder the grinding should continue for some time after the marks of the last previous grade have disappeared, especially with soft metals, since the scratches cause a flow or disturbance of the metal to a minute depth below the surface, and if this disturbed metal is not ground off, the deep effect of the scratches becomes apparent on etching. In the final polishing on the rouge disk, the sample should be continuously rotated; this is most readily done by moving the sample nearly in a circle about the center of the disk in an opposite direction from the rotation of the disk. This keeps the direction of the grinding marks constantly changing, and avoids grooving. The finishing should be done near the center of the disk, the slower motion being most effective for very fine polishing. After grinding with one grade of powder and before proceeding to the next, the samples and the operator's hands should be thoroughly washed, and the hands and the apparatus should be kept free of dust or dirt, to secure a polish free from scratches.

The most important item to be noted by the beginner is the liability of the paraffin to adhere to the samples when the grinding is begun, particularly in the case of the rouge disk. When the sample is first brought into contact with the disk, especially if the latter has been freshly prepared, the paraffin nearly always smears over the surface of the sample in a second or two, and if the sample is not removed and cleaned at once the result is a roughened disk, requiring re-turning with the hand tool and re-application of the

*From the *Journal*, American Society of Mechanical Engineers.

paste. Therefore, the sample should at first be touched very lightly to the disk, and at once removed and wiped with the finger, or with a cloth. If this is repeated several times, the surface of the sample will no longer become coated with paraffin, but can be ground continuously, except when a fresh coating of paste is required by the disk. One great advantage of the paraffin disk over disks covered with cloth or felt, is that if the disk becomes roughened or cut, it can readily be turned smooth and true again.

For cleaning the samples after polishing, the best material is a stock of old linen or cotton well laundered and cut to 3-inch squares. These small pieces are preferable to larger ones, since they can be discarded for fresh ones after once using. The old cotton or linen is also the best material for cleaning the lenses and mirrors of the optical apparatus, being superior to chamois for this purpose.

Time Required for Polishing Various Metals

The time required for polishing a sample varies somewhat with the hardness. A single sample of normal steel, cast iron, or wrought iron, may be finished in 15 minutes; a set of five or six such samples may be finished in an hour. Hardened steels require a slightly longer time. The method has not thus far proved serviceable for very soft metals and alloys, particularly lead, owing to the persistent adhesion of the paraffin to the surface of the sample. The harder alloys polish well by this process. The finished surface presents a minute relief of the harder constituents, but much less than is produced by the use of felt or other very soft materials.

The paraffin beds are more durable than might be supposed; on long standing at summer temperatures the surfaces become distorted by the flow of the wax, but they can always readily be made true by the turning tool. The harder paraffin (ceresin) offers no advantages over ordinary paraffin, except that it flows less at summer temperatures. It is serviceable for use with the emery powders, but too hard for best results with the rouge.

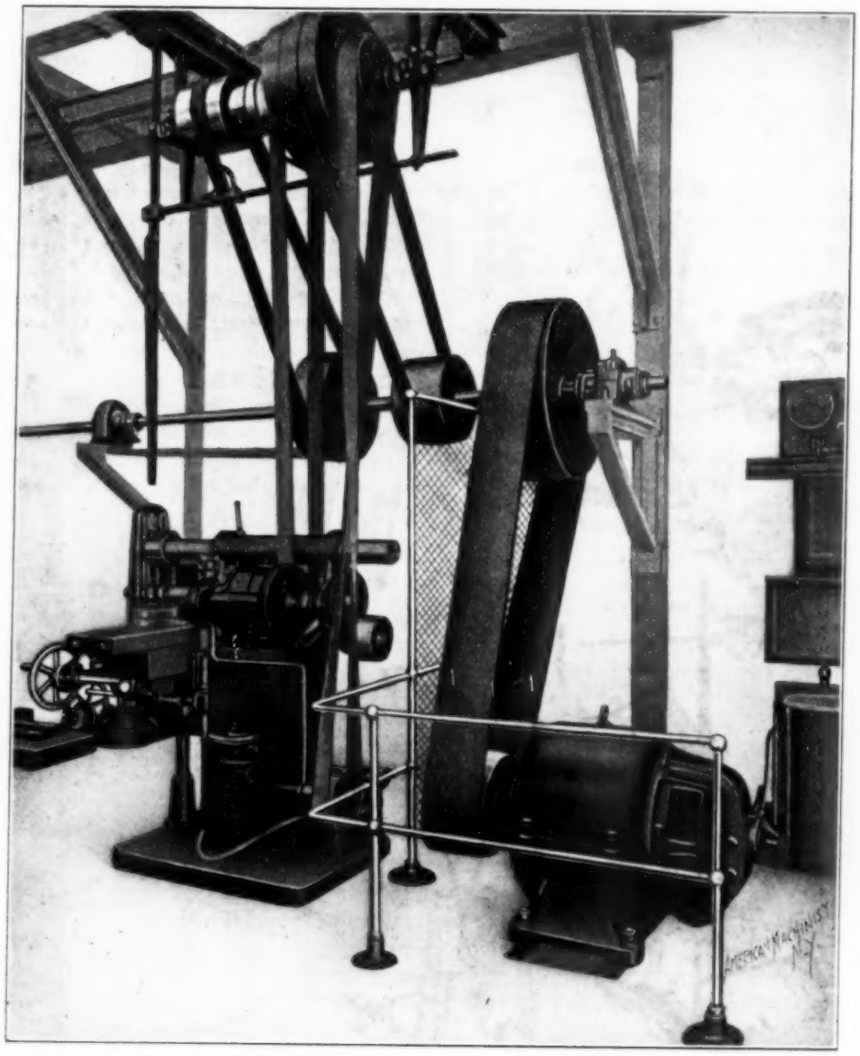


FIG. 1. MILLING MACHINE ARRANGED FOR TEST

Milling Machine Tests *

By P. V. Vernon

The tests described below were carried out in the private experimental workshop of Alfred Herbert, Limited, with a view to collecting data as to the capacity and efficiency of one of their milling machines.

The purposes of the tests were:

1. To determine the amount of metal which could be removed by a spiral cutter working on average cast iron and mild steel.
2. To measure the power consumed.
3. To ascertain the ratio between metal removed and power consumed under various conditions of cut and feed.
4. To find the combination of feed and depth of cut which would give the greatest amount of metal removed.

Depth of Cut, Inches.	Feed in Inches per Minute, Measured.	Amperes.	Volts.	Electrical Horse-power.	Motor Efficiency.	Net Horsepower Motor.	Net Horsepower Machine.	Material Removed Cubic Inches per Minute.	Material Removed Cubic Inches Per Net Machine Horsepower Minute.
0.14	10 3/8	28	222	8.3	0.86	7.2	5.4	7.39	1.33
0.16	10 7/16	30	222	8.9	0.86	7.7	5.9	8.35	1.42
0.18	10 1/2	35	222	10.4	0.87	9.0	7.2	9.33	1.30
0.19	10 1/2	38	222	11.3	0.87	9.8	8.0	9.61	1.20
0.20	10 1/2	40	221	11.8	0.87	10.3	8.5	10.12	1.19
0.21	10 1/2	42	221	12.4	0.88	10.9	9.1	10.56	1.16
0.22	9 15/16	43	221	12.7	0.88	11.2	9.4	10.89	1.16
0.23	9 15/16	44	220	12.9	0.88	11.4	9.6	11.24	1.17
0.25	7 1/2	35	220	10.3	0.87	9.1	7.3	9.37	1.28
0.27	7 5/16	40	220	11.7	0.87	10.3	8.5	9.82	1.16
0.28	7 5/16	41	220	12.0	0.88	10.6	8.8	10.01	1.14
0.29	7 5/16	41	220	12.0	0.88	10.6	8.8	10.37	1.18
0.30	7 5/16	43	220	12.6	0.88	11.1	9.3	10.73	1.15
0.31	6 11/16	44	220	12.9	0.88	11.4	9.6	10.75	1.12
0.32	6 11/16	44	220	12.9	0.88	11.4	9.6	11.10	1.16
0.33	6 11/16	44	219	12.9	0.88	11.4	9.6	10.67	1.12
0.36	5 3/4	35	220	10.3	0.87	9.0	7.2	9.67	1.34
0.38	5 7/16	38	220	11.2	0.87	9.8	8.0	10.09	1.26
0.40	5 5/16	42	220	12.3	0.88	10.8	9.0	10.37	1.15
0.42	5 5/16	42	218	12.2	0.88	10.8	9.0	11.15	1.24
0.43	5 5/16	45	218	13.1	0.88	11.7	9.9	11.15	1.12
0.44	5 1/4	48	218	14.0	0.88	12.4	10.6	11.27	1.06
0.45	5 1/16	48	218	14.0	0.88	12.4	10.6	11.46	1.08
0.50	5 1/16	50	219	14.6	0.88	12.8	11.0	12.65	1.15
0.52	5 1/16	42	220	12.3	0.88	10.9	9.1	13.81	1.52
0.53	5 5/16	43	220	12.6	0.88	11.1	9.3	13.74	1.48
0.54	5 1/2	44	219	12.9	0.88	11.4	9.6	14.17	1.47
0.55	4 3/4	52	219	15.2	0.88	13.4	11.6	13.40	1.15
0.57	5 1/2	52	221	15.4	0.88	13.5	11.7	14.60	1.24
.625	4 3/4	54	221	16.0	0.88	14.1	12.3	15.23	1.24
0.70	3 13/16	43	222	12.7	0.88	11.2	9.4	13.34	1.42
0.75	3 3/4	47	222	13.9	0.88	12.2	10.4	14.06	1.35
.775	3 13/16	47	222	13.9	0.88	12.2	10.4	14.72	1.41
0.85	2 1/4	42	222	12.5	0.88	11.0	9.2	11.68	1.27
0.90	2 1/16	45	221	13.3	0.88	11.7	9.9	12.09	1.22
0.95	1 7/8	33	221	9.7	0.87	8.4	6.6	8.90	1.34
1.00	1 7/8	34	221	10.0	0.87	8.7	6.9	9.30	1.49
1.10	1 13/16	37	220	10.9	0.87	9.5	7.7	10.13	1.31

Power required to run jack-shaft light 1.8; horsepower.

TABLE 1. POWER RECORDS CUTTING CAST IRON.

Fig. 1 is a view in the experimental workshop showing how the machine was arranged for testing. Its own countershaft was employed, with the belt driving vertically in the usual way, the conditions of ordinary use being followed as closely as possible.

The power was transmitted to the countershaft from the motor through an intermediate jackshaft running in Hyatt roller

*Condensed from *The Engineer*, of London.

bearings. Double leather belts of best quality were used throughout. The motor was a 15-brake-horsepower variable-speed motor, installed specially for making power tests, the speed variation being from 330 to 990 per minute, and the motor efficiency was known at all loads and speeds.

In order to limit the number of variables, one size of cutter was used for all the tests, and was run at a constant speed of 84 turns per minute.

The following are the particulars of the machine and of the cutter:

Longitudinal feed	28 inches.
Cross movement	9 inches
Vertical height admitted	19 inches
Largest diameter of cone pulley	11 inches
Smallest diameter of cone pulley	7½ inches
Width of belt	3 inches
Ratio of gearing	7 to 1
Number of spindle speeds	16
Range of spindle speeds	9 to 610
Number of feeds	9
Range of feeds in inches per minute	¾ inch to 10½ inches
Weight of machine with countershaft	3250 pounds

PARTICULARS OF CUTTER.

Diameter	3 inches
Length	6 inches
Size of hole	1¼ inches
Number of teeth	8
Pitch of spiral	18¾ inches
Angle of spiral	26¾ degrees
Hand of spiral	Left
Hand of cutter	Right
Material	High-speed steel.
Cutting speed	66 feet per minute

Fig. 2 shows two views of the cutter, which is of the form generally supplied and recommended by Alfred Herbert, Limited, for heavy milling. It will be seen that the teeth are of very strong form, and that there is ample room for chips.

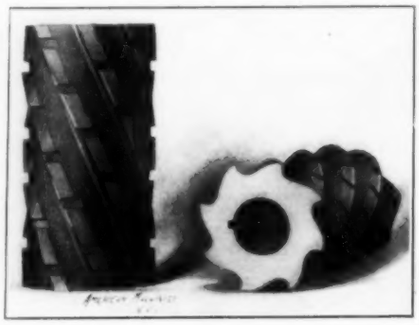


FIG. 2. SPIRAL CUTTERS USED IN TEST

The cast iron and mild steel on which the cuts were taken showed the following results when tested:

CAST IRON.

(Test bar cast from same ladle as test block from which cuts were taken.)

Transverse breaking load on 1 inch. square bar 12 inches between supports	2464 pounds
Hardness number, Brinell test	254 pounds

(Test bar cut from the body of the actual test block.)

Transverse breaking load as above	2022 pounds
Hardness number, Brinell test	222 pounds

MILD STEEL.

Tensile breaking stress	25 tons per square inch
Elastic limit	14 tons per square inch
Elongation	32.3 per cent.

The cast-iron blocks tested were 5 inches wide, 5 inches deep, and 24 inches long, and the mild-steel blocks 5½ inches wide, 5 inches deep, and 24 inches long.

It will be observed that there is a marked difference between the physical properties of the cast iron in the block and in the cast test bar, although both were cast at the same time and from the same metal, the variation being, of course, due to the difference in mass of the two castings. It is considered that the publication of both sets of tests will call attention to the ineffectiveness of the common practice of testing small cast sections in order to judge the strength of castings of large mass. Where possible the test bar should be cut from the body of an actual casting and not cast as a small projection on it.

The results of the power tests of the machine are given in tabular form, Tables 1 and 2, and as charts in Figs. 3 and 4, for the benefit of those who prefer to study tendencies in a graphic form.

When taking readings of the power consumed, both ammeter and voltmeter were read during each cut, and the watts were corrected by the efficiency factor of the motor at the load and speed used. The power required to run the jackshaft light was then deducted, the remainder being the power absorbed by the machine. No

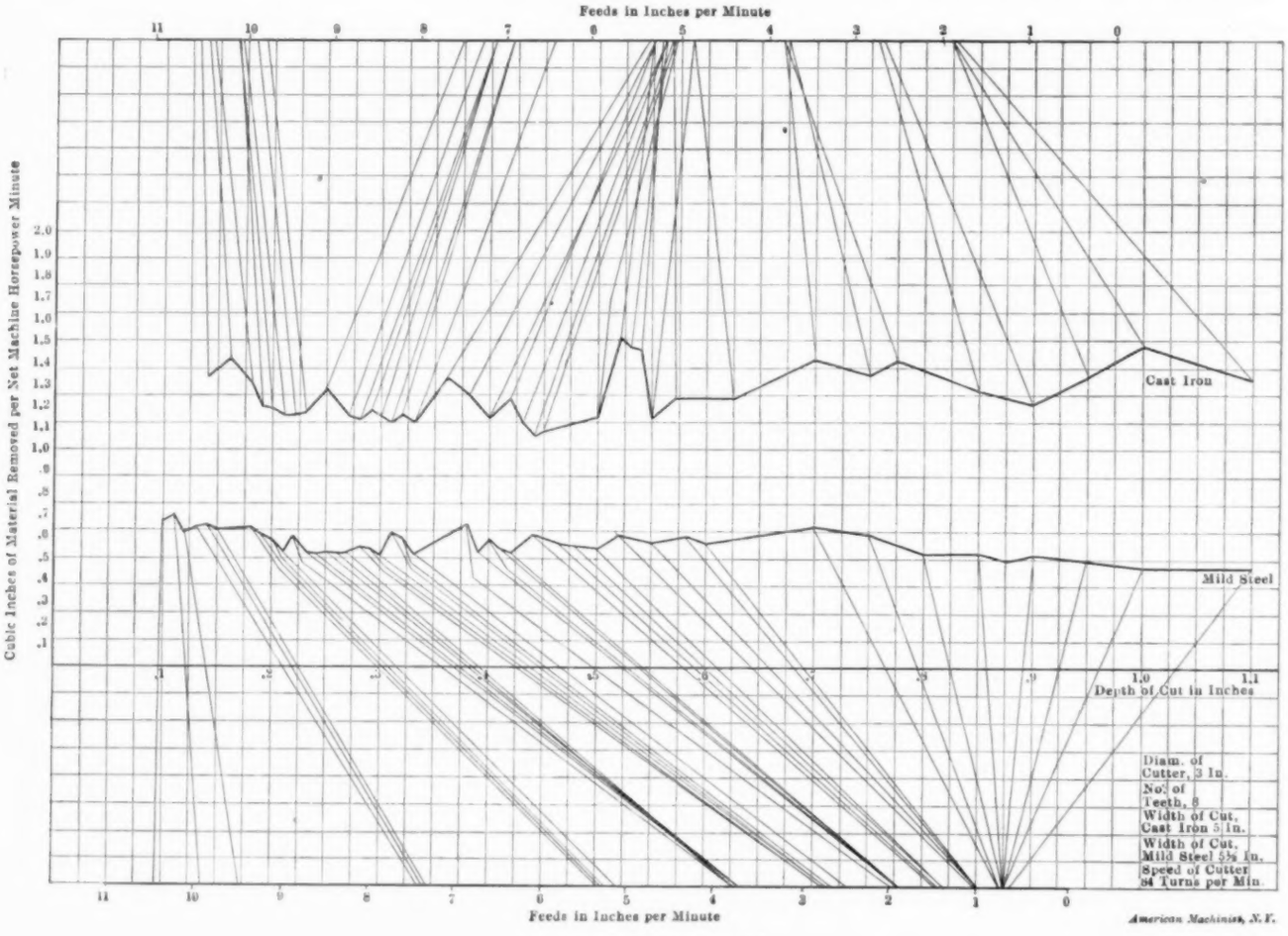

Feeds in Inches per Minute
11 10 9 8 7 6 5 4 3 2 1 0
Cubic Inches of Material Removed per Net Machine Horsepower Minute
2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3 1.2 1.1 1.0 .9 .8 .7 .6 .5 .4 .3 .2 .1
Cast Iron
Mild Steel
.1 .2 .3 .4 .5 .6 .7 .8 .9 1.0 1.1
Depth of Cut in Inches
Diam. of Cutter, 3 In.
No. of Teeth, 8
Width of Cut, Cast Iron 5 In.
Width of Cut, Mild Steel 5½ In.
Speed of Cutter 84 Turns per Min.
11 10 9 8 7 6 5 4 3 2 1 0
Feeds in Inches per Minute
American Machinist, N.Y.

FIG. 3. EFFICIENCY CHART

means were available for measuring the power absorbed by the jackshaft under load, but it is probable that the increase of power consumed under load would be very small, as the temperature of the roller bearings remained practically constant at all loads. Whatever increase there might be, however, would go to the credit of the machine, the actual efficiency of which would be if anything rather higher than the tests show.

It was at first considered that in order to obtain uniform results it would be necessary to sharpen the cutter for each cut taken, but some preliminary tests on the durability of the cutting edge showed this not to be the case. The whole of the mild-steel tests were taken without resharpening the cutter, but several of the cuts were afterward repeated with a sharpened cutter, the results being practically the same as before, showing that nothing would have been gained by repeated sharpenings.

On cast iron, however, the cutter became dull rather faster than on mild steel, and was, therefore, resharpened when it appeared to need it, viz., before taking the 0.52-inch and 0.95-inch depths. The effect of this sharpening on the efficiency chart, Fig. 3, is very pronounced at 0.52 inch depth, the efficiency line taking a sudden jump, but dropping again to normal after the third cut, indicating that the sharpening had produced a temporarily—but not permanently—very efficient cutting edge.

The effect of the sharpening at 0.95 inch depth was also shown by a slight rise in the efficiency, but was not so pronounced as in the previous instance. The effect on the output chart, Fig. 4, of sharpening the cutter appears to be rather indefinite, as the highest peaks do not correspond with the cuts taken immediately after sharpening; but, of course, it must be understood that the cutter was never allowed to become really dull.

Depth of Cut, Inches.	Feed in Inches per Minute, Measured.	Amperes.	Volts.	Electrical Horsepower.	Motor Efficiency.	Net Horsepower Motor.	Net Horsepower Machine.	Material Removed, Cubic Inches Per Minute.	Material Removed, Cubic Inches Per Net Machine Horsepower Minute.
0.10	10 1/4	40	220	11.7	0.87	10.3	8.5	5.70	0.67
0.11	9 11/32	40	220	11.7	0.87	10.3	8.5	6.00	0.71
0.12	9 1/2	47	220	13.8	0.88	12.2	10.4	6.27	0.62
0.13	7 7/8	39	220	11.5	0.87	10.0	8.2	5.30	0.65
0.14	7 1/2	40	220	11.7	0.87	10.3	8.5	5.60	0.66
0.15	7 5/16	45	219	13.2	0.88	11.6	9.8	6.00	0.63
0.18	5 5/8	40	220	11.7	0.87	10.3	8.5	5.25	0.64
0.19	5 7/32	42	220	12.3	0.88	10.9	9.1	5.50	0.61
0.20	5 1/4	45	220	13.2	0.88	11.6	9.8	5.70	0.58
0.21	5 5/32	52	222	15.4	0.88	13.5	11.7	6.10	0.52
0.22	3 13/16	38	222	11.3	0.87	9.8	8.0	4.70	0.59
0.23	3 3/4	42	222	12.5	0.88	11.0	9.2	4.80	0.52
0.24	3 5/8	45	222	13.4	0.88	11.8	10.0	5.06	0.51
0.25	3 1/2	47	222	13.9	0.88	12.2	10.4	5.27	0.52
0.26	3 13/32	48	225	14.5	0.88	12.7	10.9	5.57	0.51
0.27	3 11/32	50	222	14.9	0.88	13.0	11.2	5.78	0.52
0.28	2 13/16	38	221	11.2	0.87	9.8	8.0	4.42	0.55
0.29	2 3/4	40	221	11.8	0.87	10.3	8.5	4.58	0.54
0.30	2 5/8	42	220	12.3	0.88	10.9	9.1	4.64	0.51
0.31	2 1/2	36	223	10.7	0.87	9.3	7.5	4.68	0.62
0.32	2 13/16	38	222	11.3	0.87	9.8	8.0	4.72	0.59
0.33	2 7/8	41	221	12.1	0.88	10.6	8.8	4.53	0.51
0.38	2	32	221	9.4	0.86	8.1	6.3	4.18	0.66
0.39	1 15/16	34	221	10.0	0.87	8.7	6.9	3.60	0.52
0.40	1 13/16	35	224	10.5	0.87	9.1	7.3	4.26	0.58
0.41	1 11/16	38	223	11.3	0.87	9.8	8.0	4.36	0.54
0.42	1 5/8	40	223	12.0	0.87	10.3	8.5	4.40	0.52
0.44	1 1/2	30	222	8.9	0.86	7.6	5.8	3.55	0.61
0.46	1 7/16	32	222	9.5	0.86	8.2	6.4	3.63	0.57
0.48	1 1/2	33	222	9.8	0.87	8.5	6.7	3.71	0.55
0.50	1 1/2	35	221	10.3	0.87	8.9	7.1	3.86	0.54
0.52	1 3/32	26	224	7.8	0.85	6.6	4.8	2.94	0.61
0.55	1	28	223	8.3	0.86	7.1	5.3	3.02	0.57
0.58	1	28	223	8.3	0.86	7.1	5.3	3.19	0.60
0.60	1	30	223	8.9	0.86	7.6	5.8	3.30	0.57
0.70	3/4	25	225	7.5	0.85	6.3	4.5	2.88	0.64
0.75	3/4	27	225	8.1	0.85	6.9	5.1	3.09	0.61
0.80	3/4	30	225	9.0	0.86	7.8	6.0	3.15	0.52
0.85	3/4	32	225	9.6	0.86	8.2	6.4	3.35	0.52
0.875	3/4	34	225	10.2	0.87	8.8	7.0	3.45	0.49
0.90	3/4	34	225	10.2	0.87	8.8	7.0	3.55	0.51
0.95	3/4	35	225	10.5	0.87	9.1	7.3	3.58	0.49
1.00	3/4	38	225	11.4	0.87	9.9	8.1	3.77	0.47
1.10	3/4	38	223	11.4	0.87	9.9	8.1	3.78	0.47

Power required to run jack-shaft light, ½-horsepower.

TABLE 2. POWER RECORDS CUTTING MILD STEEL.

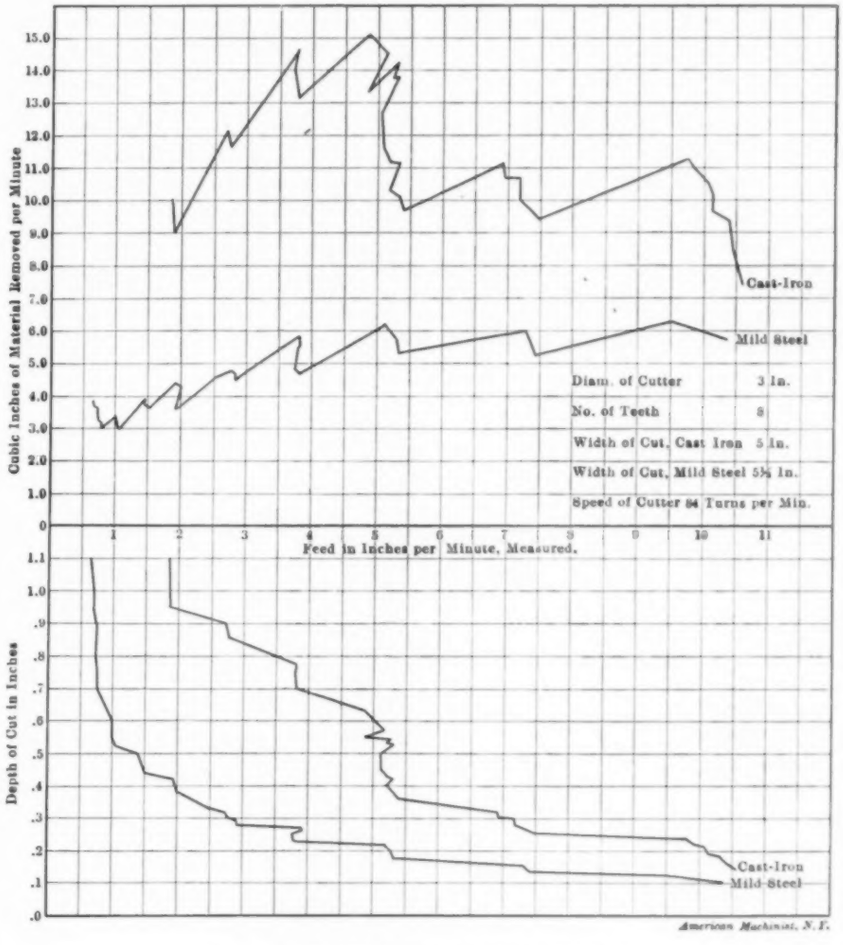

Cubic Inches of Material Removed per Minute
Cast-Iron
Mild Steel
Diam. of Cutter 3 In.
No. of Teeth 8
Width of Cut, Cast Iron 5 In.
Width of Cut, Mild Steel 5½ In.
Speed of Cutter 84 Turns per Min.
Feed in Inches per Minute, Measured.
Depth of Cut in Inches
Cast-Iron
Mild Steel
American Machinist, N.Y.

FIG. 4. MILLING MACHINE TESTS—OUTPUT

The charted results show a certain degree of irregularity, and an absence of the beautiful smoothness which characterizes the curves recently published by Mr. De Leeuw in his paper presented at the December meeting of the American Society of Mechanical Engineers, and which, therefore, appear to indicate mean results rather than actual tests, such as in the present case. At the same time, the irregularities are only such as would certainly occur even in good practice, and do not in any way obscure the facts brought out by the tests.

The method adopted when testing was to increase the depth of cut progressively, using for each depth the quickest rate of feed the machine would stand without any sign of belt slip. The actual feed was measured and was found to be less than that given by any feed indicator of the machine on all heavy cuts, owing to the motor slowing down slightly. All figures are, therefore, based on the feeds as measured, not as computed, and represent actual output.

Although the results of the tests cannot be expressed exactly by a law, yet it is possible to glean some valuable facts from them, and to draw some important conclusions.

For instance, the maximum metal removed per horsepower-minute is 1.52 cubic inches for cast iron and 0.71 cubic inch for mild steel. The latter figure shows a much higher efficiency than the 0.55 cubic inch removed by Mr. de Leeuw on a weaker grade of steel, but unfortunately no comparison is possible on cast iron, as Mr. De Leeuw has not published any tests on this material.

Another broad fact is that more than 100 per cent. more material per horsepower-minute could be removed when milling cast iron than when milling mild steel, and it will be interesting to learn whether

future tests of other machines will verify this proposition.

The charts indicate a slight gain in efficiency on cast iron and a slight loss on mild steel as the depth of cut increases, but the amount is so small that it may be said that the efficiency of the machine is nearly independent of the depth of cut on both materials within the depths tested, and varies from 1.08 to 1.52 cubic inches per horsepower-minute on cast iron, and from 0.47 up to 0.71 on mild steel. This is, of course, strictly true only when the machine approaches the maximum output, as the friction losses would be proportionately greater at a lower duty.

On the question of total output, it will be noted the maximum output obtained on mild steel was 6.27 and on cast iron 15.23 cubic inches per minute, nearly two and one-half times as much, which is about what might be expected from the relative efficiencies.

The maximum output on cast iron was obtained with a cut 0.625 inch deep at a feed of 4.875 inches per minute, and on mild steel with a cut 0.12 inch deep, at a feed of 9.5 inches per minute, from which it might be inferred that on cast iron more work can be done with a deep cut and a relatively slow feed, whereas on mild steel two or more shallow cuts at a high rate of feed might be better for removing the same thickness of material. It is possible, however, that the time required to wind back and reset the cut might swallow up the economy, especially as the variations in output at different depths of cut were much less on mild steel than on cast iron.

The Mexican Central plant at Aguascalientes for preserving railroad ties with oil, which was started some years ago as an experimental plant to develop and perfect the Ebano oil process, is now treating about a carload, or 3500 ties, daily. Each tie takes up about 3 gallons of oil.

Making Molds for Automobile Tires

EDITORIAL CORRESPONDENCE

The making of the molds in which the rubber pneumatic tires for automobiles are formed has many interesting features, and new designs, which are adopted from year to year for the tire treads cause many novel ways to be devised for machining the molds.

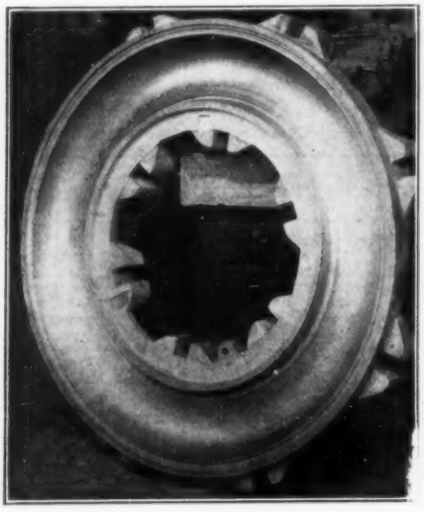


FIG. 1. ONE-HALF OF MOLD AFTER TURNING

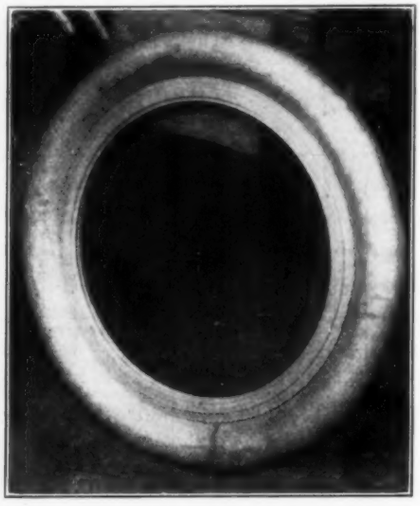


FIG. 2. CORE OF THE MOLD AFTER TURNING

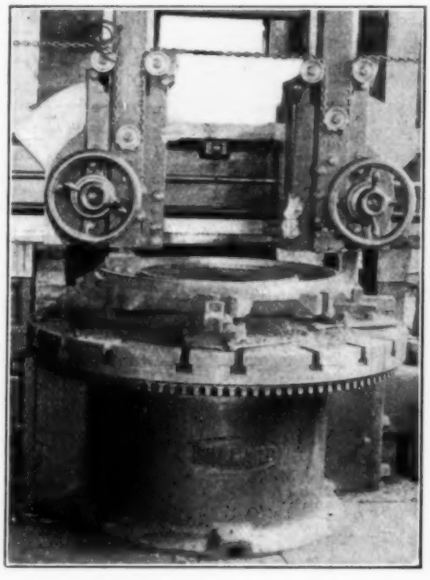


FIG. 3. TURNING THE MOLD

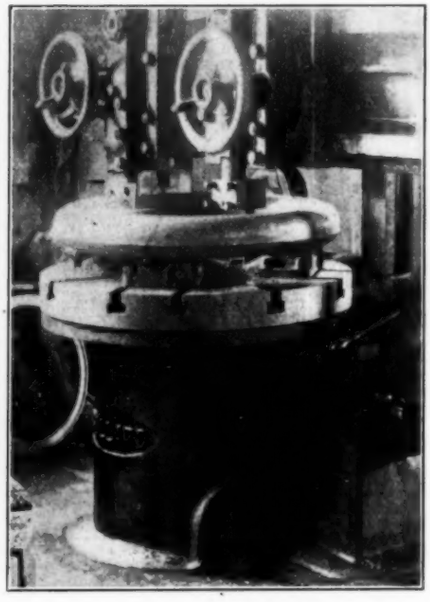


FIG. 4. TURNING THE CORE

Some of the molds, which during my recent visit were being made by the Williams Foundry and Machine Company, of Akron, Ohio, for one of the large rubber companies in that place are illustrated in this article, as well as the tools that are used in machining them.

These molds are made of a special mixture of cast iron that has a high percentage of silicon in it, and consequently they are rather difficult to machine. This mixture makes an iron that is very brittle, but as the molds are of quite a thick section, and are not submitted to any sudden shock, they stand up under the work which they are called upon to perform better than any other composition of iron that has been tried. The composition used has been decided upon as the best after many experiments.

The mold is made in two halves that are fitted together on the center line by a tongue and groove in the outer rim. One-half of the mold as it was taken from the Bullard vertical turret lathe, after being turned, is shown in Fig. 1.

The tires being hollow, to hold the inner tube a core is necessary in these molds, and the core is shown in Fig. 2. This core is made of the same kind of cast iron as the mold and fits inside of it. In molding the rubber tires the bottom half of the mold is covered with a layer of rubber a little thicker than the finished tire; the core is then lowered in the mold; a layer of rubber covered over it; the top half of the mold placed into position, and the two halves of the mold pressed together and left until the rubber has been vulcanized when the tire is taken out and the operation repeated.

The mold as it is set up and being turned is shown in Fig. 3, and the core is shown in the machine in Fig. 4. These pieces are first rough-turned and then finished to the exact size and shape by a forming cutter. The forming cutters are shown working, to the left of the illustration. A variation of only 0.002 inch is allowed in the size and shape of the mold and its core, owing to the necessity of making the tires of an even thickness.

The tire which this mold forms has nine rows of small, round disks molded on the tread part of the tire, and to mold these

the mold must have depressions in it to correspond with them. Both halves of the finished mold, with these depressions in, are shown in Fig. 5. A small part of the core is shown to the extreme right of the halftone.

To form these depressions an ingenious machine was made and operated as shown in Fig. 6. On the iron stand, to the right of the picture, is located a clutch pulley on a shaft; to the end of this shaft, by a universal joint, is connected a flexible shaft, and to this flexible shaft, by another universal joint, is connected the milling apparatus for forming the depressions. A rod is connected to the shifter that reaches over to the mold, so that the machine can be started and stopped by the operator from the work.

The first row of holes is milled on the parting line of the mold, so that when milling these the two halves of the mold must be clamped together, as shown in the extreme left of Fig. 6. As will also be seen the mold is mounted on a revolving stand in order that the holes may be easily milled around its entire circumference. The opening between the two halves of the mold when they are clamped together is only ¾ of an inch, therefore, the milling mechanism could only be that thick at this place.

The apparatus for holding and guiding the end mill as it cuts the holes, is shown in Fig. 7. As will be seen by the half holes on the parting line, this row has been milled and the other half of the mold removed. The shaft on which the end mill is located is then raised at the back end, as shown, until the end mill is brought into a position to mill the second row of holes and it is then clamped. The second row of holes is spaced half way between the row on the parting line; and the other three rows of holes, which will be milled by raising the cutter shaft still higher, are also staggered.

To locate the holes properly the apparatus revolves on the indexing plate shown in the center of the mold. This is fastened to the revolving stand on which the mold sets. Before milling the first hole the drill, shown with a bar on it for a handle, is put in the proper hole in the indexing plate and the machine moved around until its side touches this drill. The first hole is then milled, after which the drill is moved to the next hole in the indexing plate; the machine moves around until it strikes the drill, and the second hole is milled. The operation is repeated until the entire row has been milled and the back end of the shaft that holds the mill is then raised to a position that will mill the third row of holes. A stop is provided, by a collar that is clamped to the cutter shaft, so that all the holes will be milled to the same depth.

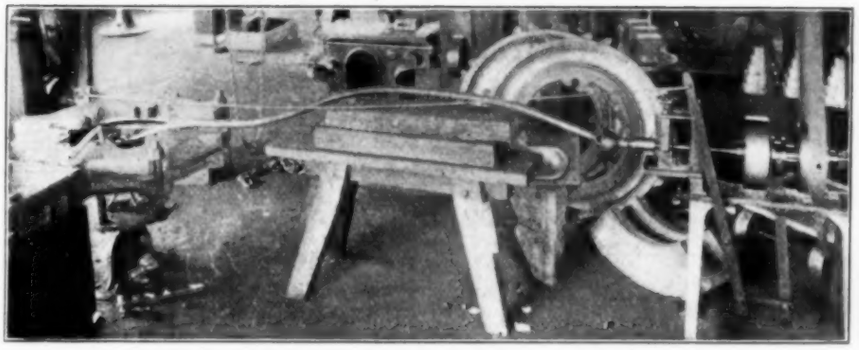


FIG. 6. MACHINE FOR MILLING DEPRESSIONS IN THE MOLD

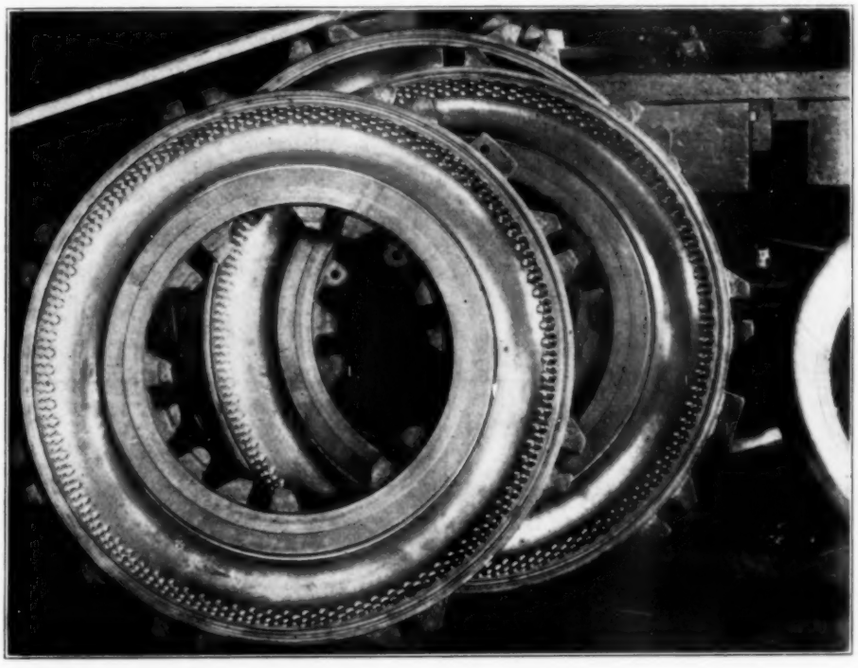


FIG. 5. BOTH HALVES OF FINISHED MOLD AND PART OF CORE

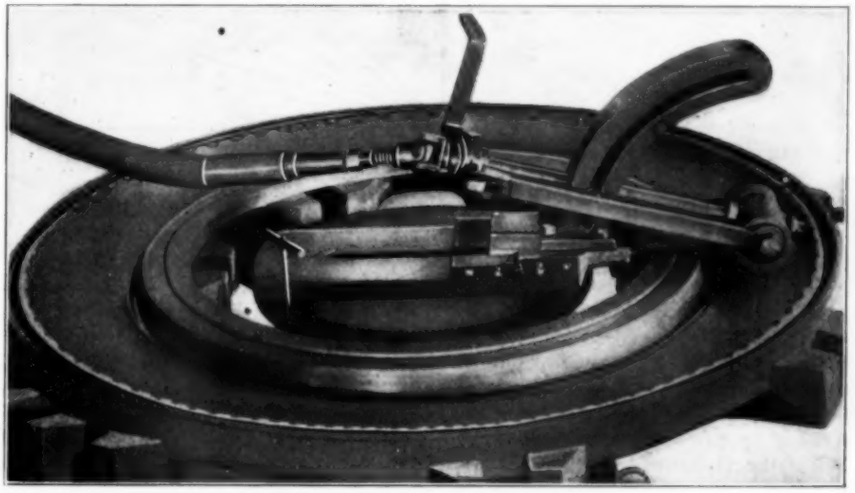


FIG. 7. THE APPARATUS FOR END MILLING THE HOLES

Panama canal excavation during March according to *Engineering News* exceeded all monthly and daily records yet made on the isthmus, with a total of 4,062,632 cubic yards, or a daily average of 150,468 cubic yards for the 27 working days. The best previous daily average was 136,908 cubic yards for the 23 days in February, 1909, and the best previous monthly total was 3,487,287 cubic yards in March, 1908, a month of 26 working days. Work on the isthmus is certainly being efficiently prosecuted.

An Investigation of the Efficiency of Files

A File Should Be Cut for Its Work—Angle and Pitch of Cuts, Clearance, Slope and Rake Angles of Teeth, All Are Important Features

BY EDWARD C. HERBERT*

In two previous articles in the AMERICAN MACHINIST I have given a description of the Herbert file-testing machine, and of some curious facts in relation to the cutting properties of files, which have been brought to light with the aid of this machine. The main purpose of the present article is to describe some investigations which have been recently undertaken, as to the relative efficiency of files of various types, on the metals most frequently met with in the workshop. It has been, and is, very generally assumed, by makers and users of files, that a "good file" is good for use on all the common metals. It has indeed been a common practice to supply files of a special cut to firms working exclusively in brass, but in the general workshop it is usual to employ files which are supposed to be equally suitable for all metals, using them on brass as long as they retain their first sharpness and afterward on iron and steel.

When the file-testing machine was introduced, it became a general practice among the largest consumers, to use the results of its tests as a basis in buying files; thus the question of the relative efficiency of files on different metals assumed a new importance. If a good file is equally good for all metals, it is immaterial what metal it is tested on. If, on the other hand, a file, to give the best result, on any particular metal, must be especially cut for that metal, it is obviously important to select the material for the test bars with especial reference to the use for which the files are intended. It was thought to be very desirable that all file tests should be made on the same standard material, so as to be strictly comparable with one another; but, on the other hand, it was important to know whether tests on such standard material would constitute a reliable basis for use in selecting files which would be mainly used on material of another character.

In order to set this question at rest, I planned and carried out a series of tests. A number of files were ordered from several makers. Each maker was requested to cut some of the files in the manner which he considered most suitable for brass, for cast iron, for steel, for wrought iron, and for general work. Six test bars were then prepared, one of each of the following metals: A very soft brass, a very hard brass, annealed cast iron, soft machinery steel, annealed cast steel and normal cast steel.

One of the special files, say one intended for cast iron, was fixed in the testing machine, and a test of 5000 strokes was made on the soft-brass bar. This bar was then removed, the hard-brass bar was substituted, and a further test of 5000 strokes was made with the same file. This was repeated with the cast-iron bar, and with each of the three steel bars in order of increasing hardness. When all the bars had been operated on, the file had made 30,000 strokes, 5000 on each bar, and the resulting diagram consisted of six straight lines sloping at various angles, the slope in each case indicating the efficiency or rate of cutting of the file on one of the

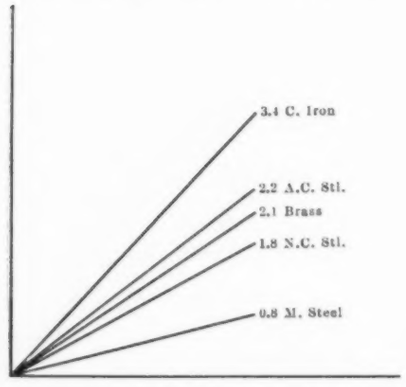


FIG. 1. TESTS OF AN ORDINARY FILE ON DIFFERENT METALS

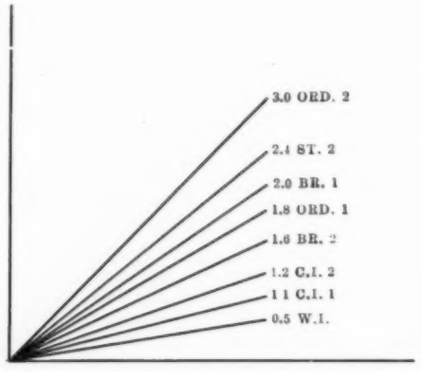


FIG. 2. TESTS ON SOFT BRASS

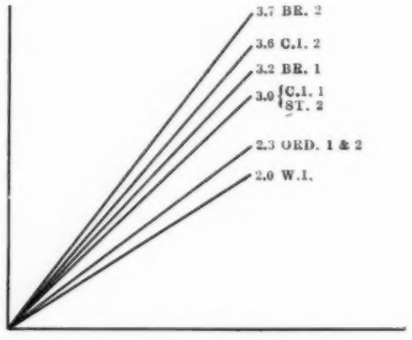


FIG. 3. TESTS ON HARD BRASS

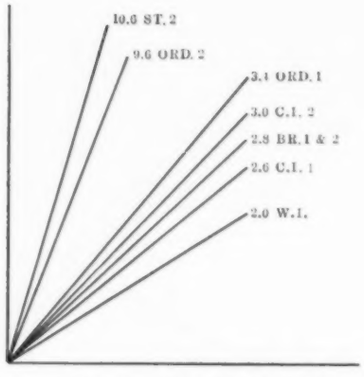


FIG. 4. TESTS ON CAST IRON

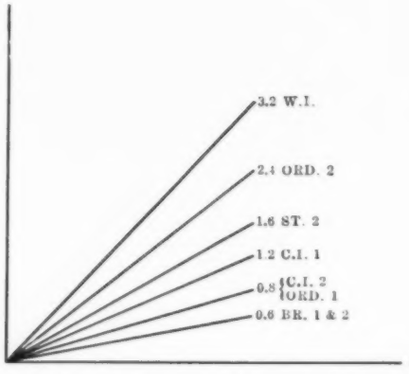


FIG. 5. TESTS ON MACHINERY STEEL

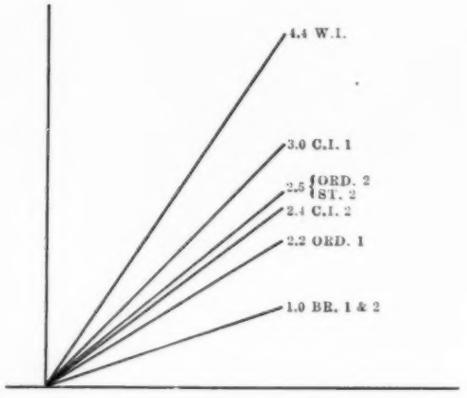


FIG. 6. TESTS ON ANNEALED CAST STEEL

*Director, Edward C. Herbert, Ltd., Manchester, Eng.

six test bars. The same series of six tests was made with one file of each of the kind supplied by each maker. One of the resulting diagrams is shown in Fig. 1.

Results of the Tests

The next step was to plot out all the results afresh, placing all the tests on soft brass together, all the tests on cast iron together, and so on. The results are given in Figs. 2 to 7 inclusive. The numbers on the right hand indicate the efficiency of the various files, measured by the number of inches filed off the bar per 10,000 strokes. Files by two different makers are distinguished by figures 1 and 2, thus *Br2* means the file cut for brass by maker No. 2; *Ord*1 means the ordinary or "general work" file by maker No. 1.

It may be said at once that these files proved to be generally unsuitable for the metals for which the makers intended them, but the names are retained for convenience in distinguishing the various files. Considering first the tests on soft brass, it will be seen that the two files which gave the best results were intended for steel and for general work respectively. The two brass files were third and fifth, and the least efficient file was one intended for wrought iron.

On hard brass, the two brass files were first and third, and this was the only case where the best result on any metal was obtained with a file intended for that metal. The wrought-iron file again gave the worst result.

order was maintained. The brass files remained at the bottom and the wrought-iron file at the top, cutting about 50 per cent. faster than the cast-iron file which took the second place.

On normal cast steel this cast-iron file gave the best result, the brass files had risen considerably and the wrought-iron file was last.

Before attempting to draw inferences from these results it may be well to say

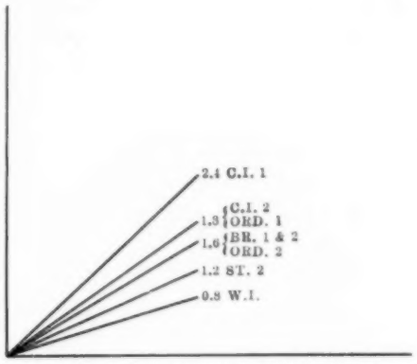


FIG. 7. TESTS ON NORMAL CAST STEEL

something about the files. The most noticeable difference between them was in the slope of the cut. The two brass files had the principal or "up cut" almost at right angles to the axis of the file. In the wrought-iron files, this cut lay at an angle of 42 degrees which is far more acute than in the ordinary file. In file *CI*1 the slope was more acute than usual, but less so than in the wrought-iron file, the angle being 64 degrees. In all the other files the slope was similar to that usually found in files supplied for general use, the angle of the up-cut varying from 69½ to 74½ degrees.

General Review of Results

A general review of these results suggests that there is a connection between the ductility of the metal, and the slope of the cut, which files it most efficiently. Probably in this, as in most cutting operations, the chip is the key to the problem. A file with the cut nearly at right angles to its axis (such as a brass file), if used on soft steel, immediately becomes clogged. The metal is compressed into irregular lumps which fill up the spaces between the teeth and prevent further cutting. On a "short" metal, like very hard brass, or fairly hard tool steel, this action does not take place. The chip breaks up into very small fragments which fall away and leave the file clear, as they have no tendency to adhere. On the other hand, a file with a very sloping cut when used on soft steel does not compress the metal into compact masses in front of the teeth, but allows it to flow in comparatively long, curled chips. Such a file has no tendency to clog, even on the most ductile metal. On a short or brittle metal it entirely fails probably because the chip breaks off as soon as it is started, and the file tooth, being set at an angle, slips out of the groove which it has begun to cut.

Placing the metals in the probable order of their ductility and beneath them the up-cut angles of the files which worked them most efficiently, we obtain the following result:

Metal.....	Hard Brass.	Cast Iron.	Soft Brass.	Normo Cast Steel.	Annealed Cast Steel.	Machinery Steel.
Slope of Cut....	91°	74½°	70°	64°	42°	42°

TABLE 1. METALS CUT AND EFFECTIVE UP-CUT ANGLES OF FILES.

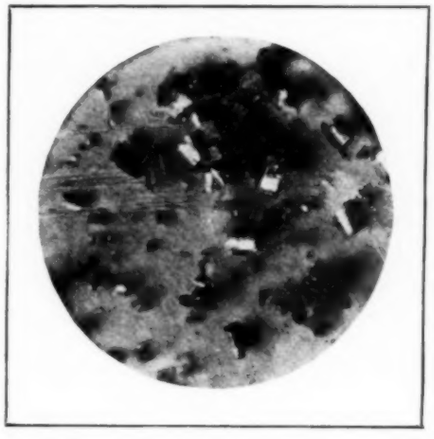


FIG. 8. FILINGS—BRASS FILE ON BRASS

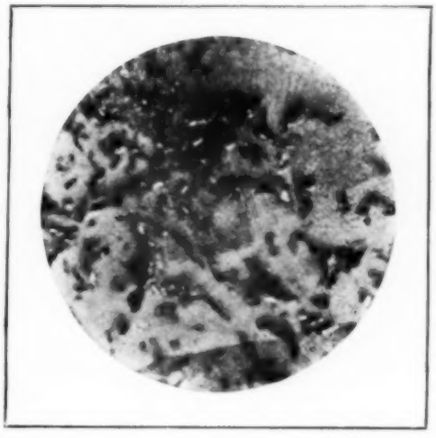


FIG. 9. FILINGS—ORDINARY FILE ON BRASS

FIG. 10. FILINGS—STEEL FILE ON BRASS

On cast iron the two files which gave the best results on soft brass were again at the top, cutting three to five times as fast as any of the others. The wrought-iron file was still at the bottom.

The tests on machinery steel show a marked change. The wrought-iron file has come from the bottom to the top, proving much more efficient than any of the others. This file was stated by the maker to be "unsuitable for steel." The brass files were together at the bottom.

On annealed tool steel much the same

It does not, of course, follow that these angles are the best possible for the respective metal, but they were the best that were to be found among the particular files used in making the tests.

It seems possible to draw certain general inferences from these results:

First. In making tests for the selection of the best make of files, it is quite necessary to use a test bar of material similar to that on which the files will be used. Thus an establishment building textile machinery or machine tools will probably

do at least 90 per cent. of its filing on cast iron. The steel work will be generally finished on the lathe or other machine tool and will require no filing. Such an establishment testing files on steel and selecting the type which gave the best results on that metal would be led to adopt files with an especially sloping cut, which would be quite unsuitable for 90 per cent. of the work they had to do. In such a case the tests should obviously be made on cast iron, and the file selected would then be suitable for 90 per cent. of the work, though probably very inefficient on the remainder.

rate of cutting of a new file generally lies between 1 and 3 inches per 10,000 strokes on steel, and between 2 and 4 inches on cast iron. To realize the loss of efficiency which results from the attempt to make an "all-round" file, it is only necessary to compare these rates with the maximum rates that are attained by files properly cut for the two metals; namely, 6 to 7 inches on steel and 10 to 15 inches on cast iron. With the ordinary or all-round file a workman has to make 2 to 10 or more strokes in order to remove an amount of metal that would be taken off with one stroke of a

tice this would not be likely to happen; the difference in appearance is considerable and might be increased by the use of distinctive handles. But even if a mistake were made in selecting a file, it could not fail to be instantly discovered. A file with a very sloping cut would work steel with great ease, but if such a file were tried on brass or cast iron, it would at once be found impossible to work with it. Similarly a file having a cut suitable for cast iron or for brass would work these metals easily, but if inadvertently tried on steel it would immediately choke up, and would cut so badly that the mistake would

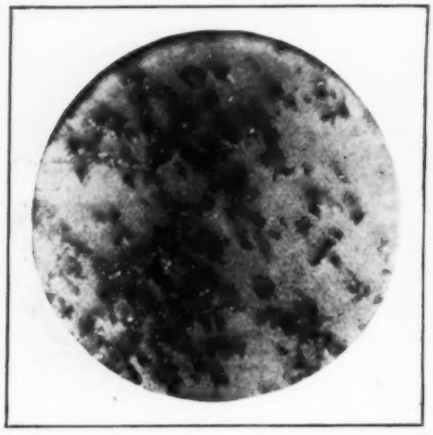


FIG. 11. FILINGS—CAST-IRON FILE ON CAST IRON

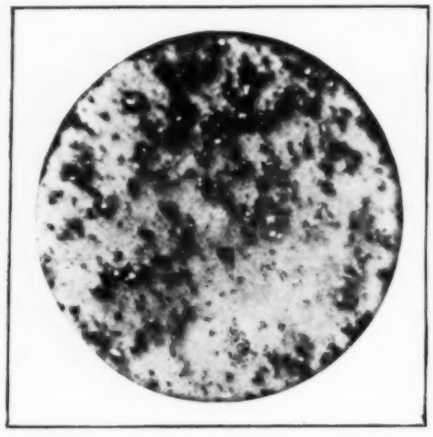


FIG. 12. FILINGS—ORDINARY FILE ON CAST IRON

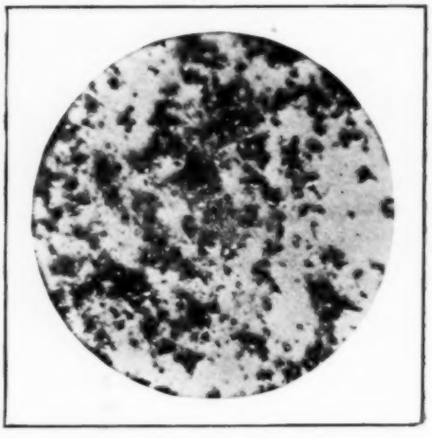


FIG. 13. FILINGS—STEEL FILE ON CAST IRON

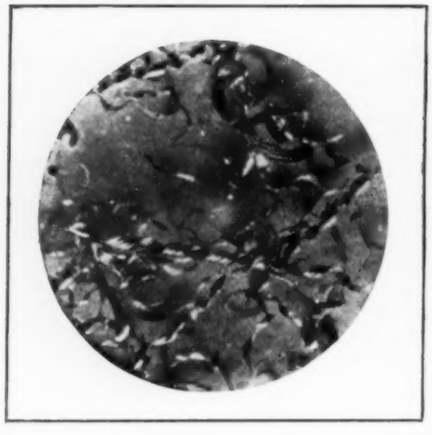


FIG. 14. FILINGS—STEEL FILE ON MACHINERY STEEL

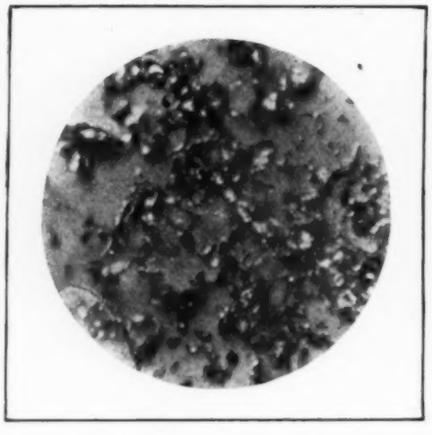


FIG. 15. FILINGS—ORDINARY FILE ON MACHINERY STEEL

FIG. 16. FILINGS—CAST-IRON FILE ON MACHINERY STEEL

Second. Judging, however, from the results of the series of tests under consideration, it would seem that the "file for general work" is a mistake. The only files which were equally efficient on all metals were decidedly inefficient on all metals; that is to say, they would compare very badly on any given metal with a file whose cut was especially suited to that metal. This is amply borne out by most of the experience so far obtained with the file-testing machine. The great majority of the files which have been tested for engineers have proved to be about equally inefficient on cast iron and on steel. The

file properly cut for the metal in question; it is scarcely necessary to point out the important bearing which this has on the wages cost of any work involving the use of files.

Third. These considerations clearly point to the conclusion that there would be great economy in supplying each workman with a set of files especially cut for each of the metals on which he is likely to work. It might at first sight appear that the difficulty in distinguishing the various types by their appearance would often lead to files being used on metals for which they were unsuitable. In prac-

be discovered at once. The ordinary or all-round file is a compromise, not very bad nor very good for any metal. It has a decided tendency to choke on steel, and much time is wasted in clearing it. On the other hand it is very slow and inefficient on cast iron or brass, in comparison with files correctly cut for those metals.

The proposed change would involve the carrying of larger stocks of files, but there is good reason to believe that the total consumption of files would be reduced. Experience shows that a file which cuts efficiently, retains its cutting proper-

ties longer than one which cuts badly; indeed this is the common experience with cutting tools in general. An inefficient tool is one which offers great resistance to the flow of the metal being cut, and great resistance necessarily involves rapid wear.

An Examination of Filings or File Chips

It is possible to gain some insight into the working properties of a file by examining the filings made by it, as will be seen from the micro-photographs, Figs. 8 to 21, inclusive, which show filings of brass, cast iron, machinery steel and cast steel made by variously cut files. The magnification is about 10 diameters. The central figure for each metal represents filings made by a good file of the ordinary or compromise type; the figure on the left represents in each case filings made by a file correctly cut for the particular metal it was working on, and the figures on the right show filings from files correctly cut for metals other than those on which they were working.

Thus Fig. 8 shows brass filings from a properly cut brass file; Fig. 10 shows brass filings made by the correctly cut steel file which produced the steel filings in Fig. 14. It will at once be noticed that filings in the lower numbered figures are generally large and of regular form. Those in the higher numbered figures are broken up into small irregular fragments; those in the central figures are more or less broken up, consisting of some large and many small irregular fragments. All the higher numbered figures represent a very slow rate of removing metal, and all those of the lower numbered a very quick rate. The ordinary file was decidedly slow on all metals.

The brass filings, Fig. 10, made by a file with very sloping cut, have great regularity, and would appear to indicate efficient cutting. As a matter of fact such a file cuts brass very slowly, the filings are extremely thin, and can only be produced while the file is very sharp. The brass filings shown in Fig. 8 are much thicker, and can be produced with a file which has lost its first sharpness.

The appearance of cast-iron filings made by quick- and by slow-cutting files differs less than in the case of the more ductile metals, owing to the crumbling nature of the metal, but the cutting efficiency of files shows greater variations on cast iron than on any other metal. The rate of removing metal varies from less than 1 inch up to 15 inches per 10,000 strokes under the standard test conditions. In the case of steel, the filings give a clear indication of the cutting efficiency. If the steel is reduced to fine powder it is pretty certain that the cutting is slow. On the other hand a regular curled chip indicates a correctly formed tooth, but does not necessarily indicate a quick rate of cutting. In the same way as in the lathe, a good form of tool is essential to the rapid removal of metal, but something else is required—a quick feed or a deep cut. Many files produce beautifully curled filings while cutting very slowly. The teeth are correctly formed but the feed is too slow. The feed, in a file, depends on the ratio between the pitch, or coarseness, of the up-cut and over-cut, a matter which will be referred to later.

FIG. 17. FILINGS—QUICK FILE ON CAST STEEL

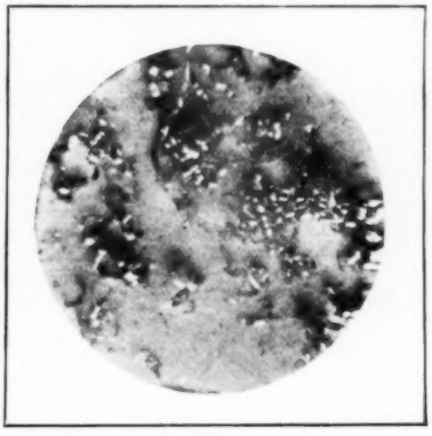


FIG. 18. FILINGS—ORDINARY FILE ON CAST IRON

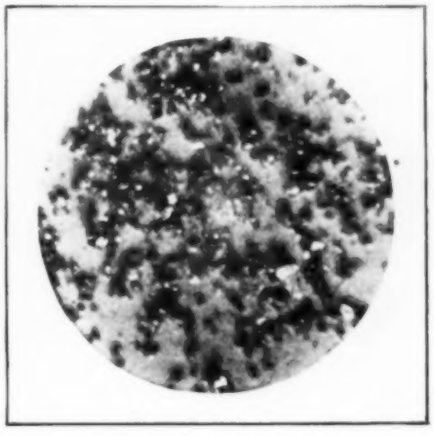


FIG. 19. FILINGS—SLOW FILE ON CAST STEEL

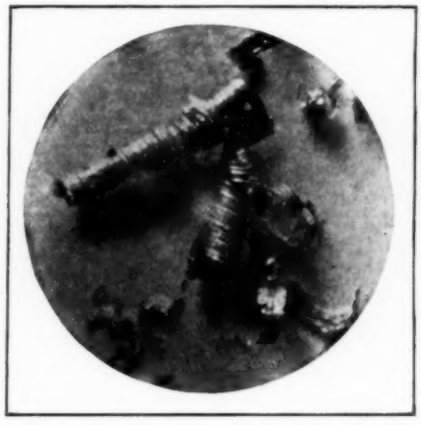


FIG. 20. FILINGS—CIRCULAR-CUT FILE ON STEEL

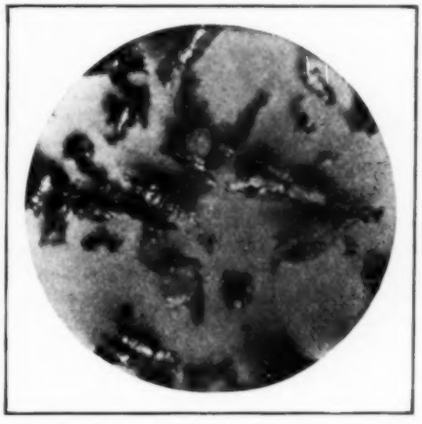


FIG. 21. FILINGS—CIRCULAR-CUT FILE ON CAST IRON

Figs. 20 and 21 represent filings made by a file with teeth of circular form, produced by a milling process. In these files the cutting edges lie comparatively far apart, and are not broken up by a cross cut as is the case with ordinary files. The filings consist of broad flakes, usually curled up, but not drawn out into helical form. The cast-iron chips are less broken up than those from ordinary files, probably because of the ample space between the cutting edges.

No fact has been brought into greater prominence by the file-testing machine than this: the total output of work that can be got from a file depends much more on the formation of the teeth than on the quality of the steel of which it is made. Good steel is as important in files as in any other cutting tools, but it has been repeatedly shown that a properly cut file made of quite a common quality of steel will do much more work and last much longer than one made of the highest quality of steel procurable, but having badly formed teeth. This important influence of the cut on the durability is only beginning to be appreciated by file makers, and before the advent of the file-testing machine it was generally ignored or unsuspected.

Clearance and Rake of File Teeth

In the present article reference has been chiefly made to the slope of the cut in relation to the axis of the file, in its bearing on efficiency and, therefore, on durability. There is another angle which appears to have very little influence on efficiency, but which is probably the most important of all the factors determining durability and output of work; namely, the clearance angle, or slope of the back of the file tooth. In Fig. 22 are shown two file teeth having a large and a small clearance angle, respectively. The shaded area represents in each case that portion of the tooth which is available for wear. When this portion has been worn away each tooth will present an equal surface of contact to the work; in other words, each will be equally blunt. It will be at once apparent from this illustration how the clearance angle affects the life of the file by determining the volume of that part of the tooth which lies outside the limiting surface which is exposed when the file is worn out.

Other things equal, the life of the file should be directly proportional to the tangent of the clearance angle of its teeth, provided this angle is not so great as to seriously weaken the teeth and render them liable to breakage. A good quality of steel and correct temper are, no doubt, important in enabling an acute form of file tooth to withstand severe usage without breaking, but it may easily happen that a high quality of steel and especially a high-carbon steel, is actually prejudicial to the durability of the file. Such steel has very little ductility and does not "rise" to the blow of the cutting chisel as readily as a softer and more ductile steel. Therefore, unless special care is taken in the cutting, a flat-topped tooth with very little clearance is produced and such a tooth after a small amount of wear presents a broad surface to the work, and cannot be made to cut without excessive pressure. This is, no doubt, one reason why some files made of high-quality steel and assumed to be specially good files, have given very disappointing results when tested.

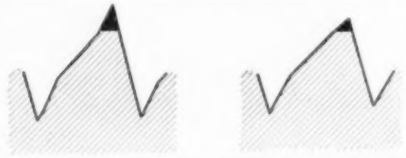


FIG. 22. CLEARANCE ANGLES OF FILE TEETH

It might naturally be supposed that the sharpness of a file would be the principal factor determining the rate at which it would remove metal. Sharpness is certainly important, but general experience of file testing points to the conclusion that mere keenness of edge is of relatively slight importance compared with correctness of the angles of rake, clearance and slope. This fact is well illustrated by the diagrams in Fig. 23, taken from two files which were equally sharp and which cut at exactly the same rate when new. File *A* evidently owed its efficiency to mere sharpness. The teeth were badly formed, and as soon as they had become slightly blunted by a few thousand strokes of use, the efficiency fell to a very low rate. File *B* was not only sharp, but correctly cut. It no doubt lost its original keenness of edge as soon as file *A*, but its efficiency was scarcely affected, and remained almost constant during the whole of its life.

It is clear, than, that the quality of a file cannot be inferred from its sharpness when new, or from the quality of the steel it is made of. Both its efficiency and its durability depend mainly on the angles of rake, clearance and slope given to the file teeth, and very little appears to be known as to the effect of an alteration in any of these factors. I have measured all the angles of some hundreds of files by various makers, but have never yet seen a file whose teeth possessed positive rake, nor have I met a filemaker who could say what would be the effect of positive rake on the cutting properties of the file. Positive rake is regarded as essential in almost all cutting tools (milling cutters excepted), yet the front face of file teeth slopes backward at an angle usually between 5 and 20 degrees. All files have considerable negative rake. It appears that they have always been made so, but nobody seems to know why, or to have tried making them in the way that all experience with other cutting tools indicates as being best; namely, with positive rake. This is a matter urgently needing investigation.*

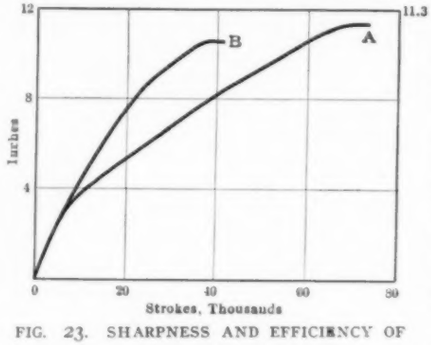


FIG. 23. SHARPNESS AND EFFICIENCY OF FILE

Connection between Pitch and Efficiency

The testing machine has thrown some light on the connection between pitch or coarseness of cut and efficiency. It is often assumed that a very rough file will cut quickly though it has the disadvantage of leaving a rough surface on the work. The testing machine has shown that very rough files are almost always very slow and inefficient. From 20 to 25 teeth per inch in the up-cut usually give the highest efficiency. A coarser cut leaves a rough finish on the work and gives a lower efficiency, so there appears to be nothing to justify it. A smooth file usually cuts slowly, though a fairly high efficiency is sometimes obtained. It may be thought that the rate at which metal can be filed away with a smooth file is unimportant, since such files are not generally used to remove metal, but to produce a smooth surface, but this is a mistake. The only function of a file is to remove metal, and although the removal of the metal may be only a secondary consideration in filing to produce a smooth surface, the most efficient file, that is, the file which cuts quickest will produce the desired result in the shortest time. Efficiency is no less important in smooth than in rough files.

FIG. 24. RATIO BETWEEN UP-CUT AND OVER-CUT

In discussing the pitch or coarseness of cut reference has been made only to the up-cut. It may not be generally known that pitch of the up-cut and of the over-cut are never the same. If they were the teeth would lie in rows parallel with the axes of the file. Each tooth would follow exactly in the groove cut by the tooth immediately in front of it, and the result would be to produce on the work a series of grooves or furrows with ridges between them. To avoid this effect the two cuts are made with slightly different pitch, that of the over-cut being usually the coarser. As a result of this arrangement, any given tooth does not lie immediately behind the tooth in the row in front, but slightly to one side of it. The action of file teeth is in fact similar to that of the cutters in a gang-planer tool. If the cutters are all set in line with the direction of cutting, the front one does all the work, and those behind follow in its path without cutting. A file cut in this way when seen in cross-section would have the appearance of *A*, Fig. 24, in which only the teeth in the front row are visible, the remaining teeth lying directly behind and being hidden by them.

If instead of making the two cuts equal in pitch we made the number of teeth per inch in the ratio of 3 to 2, the result will be that shown in *B*, Fig. 24, the teeth working in gangs of two. If the ratio is 4 to 3, there will be three teeth in a gang as in *C*, Fig. 24. The relation is expressed by the formula

$$O = \frac{N\,U}{N+1},$$

or

$$N = \frac{O}{U-O},$$

where

N = Number of teeth in a gang,
O = Number of teeth per inch in the over-cut,
U = Number of teeth per inch in the up-cut.

*Since this was written several files with positive rake have been tested and have given very good results.

In practice the number of teeth in a gang varies from 2 to 30 or 40. It is obvious that the number of teeth in a gang determines the feed, or the thickness of the chip taken off by each tooth, and it is possible for a file with very good teeth to cut slowly because the feed is too small. Judging by the great variation that is found in the ratio between the two cuts it would appear that this matter has not been thoroughly investigated by most file makers. It is probably one of the most important factors in the efficiency of files.

An Adjustable Angle Iron

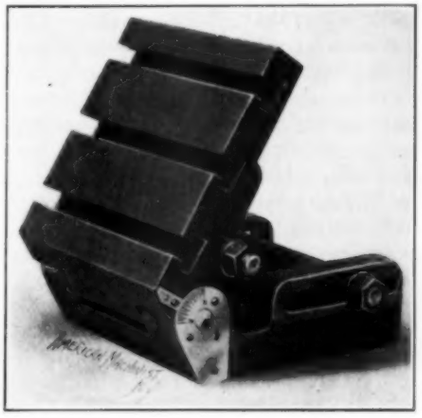
By W. Pockrandt

A device which has proved its worth in the works of Ludw. Loewe & Co., Berlin, Germany, is now placed upon the market by that firm. This device, an adjustable angle iron, serves to hold work at a predetermined angle and is especially for such work as is not abundant, and for which, it follows, a special fixture can not be made, because the expense of developing such a special holding device can only be met by a large number of pieces of the same kind.

From the accompanying halftone the adjustable angle iron can be found to apply to pieces of work on various machines; that is, if one wishes to bore holes at a set angle, or to mill and plane sloping faces.

Each section of the angle iron is a heavy cast-iron plate. These are fastened together by a joint; near the middle are sliding connections through which by tightening the clamping screw the two parts can be rigidly clamped to one another at any angle between 0 and 90 degrees. The locating is aided by a graduated dial on the side from which angles can be read.

To fasten the work in place, one of the two plates has three T-slots; the other has a bored hole in which a pin can be put to serve in locating the hub of a belt pulley or similar piece. Smaller pieces, such as cannot be fastened directly to the adjustable angle iron are held in a hand vise, which then is clamped fast to the angle iron. Both faces of the angle iron



AN ADJUSTABLE ANGLE IRON

are carefully planed and are absolutely parallel one with the other when the angle is entirely closed.

Watch Lathe Attachment for Grinding Small Steel Rolls

By W. H. Brown

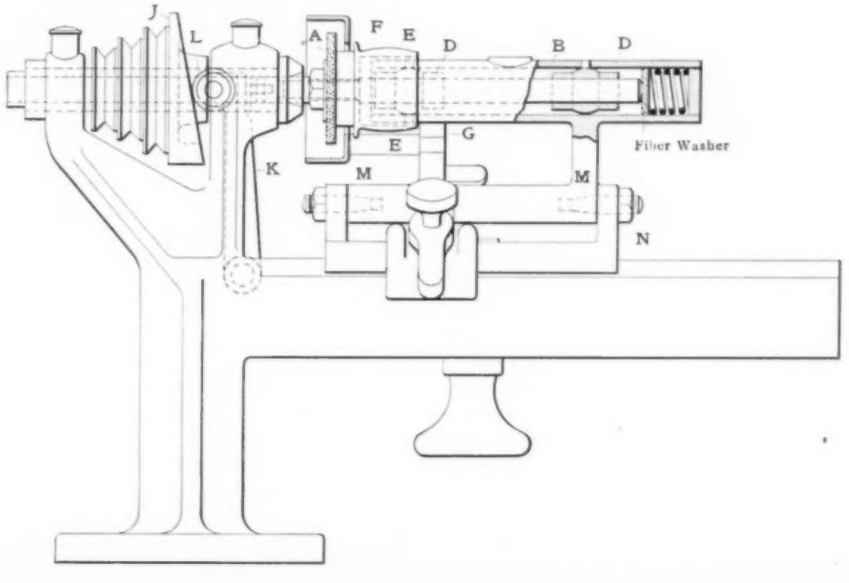
In the accompanying drawing is shown an interesting watch-lathe attachment designed and used by a typewriter concern in New England for grinding small steel rolls.

The emery wheel *A*, which is about 2 inches in diameter and ⅛ inch thick, is clamped to the end of a spindle *B*. This spindle, which is carried by the swinging head *C* works back and forth in the two bearings *D*, which are held in position by screws *E*. On the emery-wheel end of the spindle is keyed a 1¼x¾-inch pulley *F* over which runs a belt from above. Protruding from the upper part of the swinging head *C* and opposite the arm *G* is an arm *H* to which is attached a guard for the emery wheel.

The spindle *B* is forced in one direction by the end of the vertical arm *K*, which receives its motion from a small roller *L* that contacts with the face of the cam *J*; it is forced in the opposite direction by a spring inclosed in the end of the swinging head *C*, as shown in the drawing. This reciprocating motion is limited to ⅛ inch, but a greater movement can be had by using another cam *J*.

The swinging head *C*, which pivots on the tapered pins *M* in the ends of the carriage *N*, has its forward position regulated by the adjusting screw *O*, which works in a split arm *P*. When this screw is set in the proper position it is clamped fast by the binding screw *Q*. In the end of the arm *G* that protrudes from the front of the machine is a screw *R*, which not only throws the emery wheel away from the finished roll, but forms means whereby the wheel can be brought into proper position gradually, as needed. Both screws are used in taking up the wear of the emery wheel.

In connection with this machine is an indicator that tells when the roll to be ground is to the correct size. This indicator is fastened to the top of the carriage. One of the indicator arms has a roll *S* on its extreme end that comes against the roll being ground, and another arm *T*, which is pointed, rides along the face *U*, which is graduated to read in thousandths, the zero mark denoting the exact size of the roll when finished. This indicator can be set to accommodate various sizes of rolls.



GRINDING ATTACHMENT FOR WATCH LATHE

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Novel Combination Drilling and Milling Device

The accompanying sketches show the method of machining a guide plate, shown in Fig. 1. This plate is made of cast brass and used on a typewriter as a guide for the type bars; it has 26 slots through it which are machined by the special drilling and milling device shown in Fig. 2. Prior to the adoption of this special tool these plates were machined at considerable expense and to avoid this they were cast in a metal die, but this also was abandoned later due to the weakness of the metal used.

The leading feature of this device is its flexibility which makes it possible by means of a set of master former plates and holes to produce the desired 26 slots in the correct relative positions in the brass casting *A*, as shown in Fig. 1. These slots are all of the same width, yet each one forms a different angle and most of them have different curves. If it were not for this variation in the angles and curves the job would have been made on a press in preference to milling by the special tool.

In construction the device is similar to an ordinary hand drill with an extension arm on one end for locating it in a fixed spot ahead of the drill *B*. This drill, as shown in Fig. 7, is of special design; the end is like a two-lip drill, while the sides are grooved similar to a side mill and are used for milling the slots after the end has made the opening through the brass casting. This combination drill and mill has a tapered shank that fits in a tapered hole in the end of the spindle. Near the end of the spindle, as shown in Fig. 2, is fastened a miter gear which meshes with a similar gear on the end of the vertical shaft, the power for driving these gears being transmitted from the small flanged pulley *C* by means of a universal adjustable spindle *D*. This pulley *C* is held in a bracket attached to the end of a cross-rail secured to an upright post running from bench to ceiling, and is driven by a belt from a large pulley *E* attached to the opposite end of the cross-rail.

Attached to one end of the cast-iron frame that supports the two miter gears is an extension arm *F*, which is so constructed as to pass around the brass guide

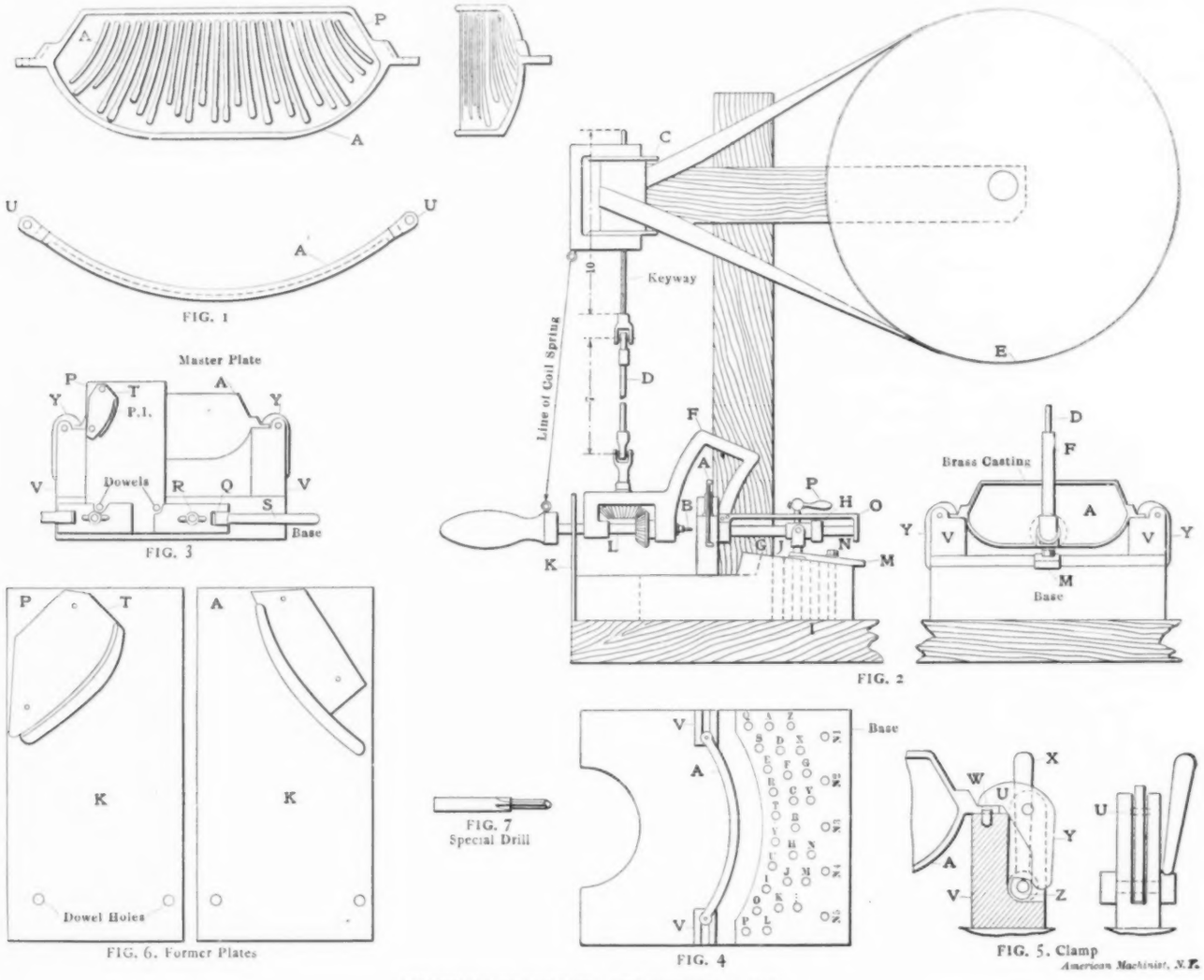


FIG. 1

FIG. 3

FIG. 6. Former Plates

FIG. 2

FIG. 7
Special Drill

FIG. 4

FIG. 5. Clamp
American Machinist, N.Y.

COMBINATION DRILLING AND MILLING DEVICE

A and support a small shaft *G* central with the drill *B*; the purpose of this shaft *G* is to support the adjustable bushing *H*, casting *J* and stud *I* in the proper position to accommodate the 26 holes designated by letters of the alphabet, as shown in Figs. 2 and 4. The bushing *H* is pivoted in a U-shaped casting *J*, and it will be readily seen that by this arrangement this end of the device can not only slide in and out, but will turn in any desired direction to accommodate the travel of the spindle *L* in the grooves in the former plates *K*. To prevent the stud *I* from working up out of the holes in the base plate a strap *M* is provided to span the shoulder on the side of the stud, this strap being held in place by the screw *N*, which in turn will screw in the five holes *N*1, *N*2, *N*3, *N*4 and *N*5 of Fig. 4. Above shaft *G* is the angle piece O, which is fastened at one end to the extension arm *F* and secured at the other end by a screw in the end of shaft *G*. In the top face of piece *O* is a slot running its entire length, and through this slot works a stud to which is attached the small locking lever *P*; the purpose of the stud passing through the slot is to keep the extension arm *F* always in the correct vertical position to clear the work *A*.

The portion of spindle *L* which passes through the end of the miter-gear bracket finds a support for its extreme end within the miter gear, but does not revolve with it and the drill. On the other end of this spindle is an ordinary wood handle to which is attached a long coil spring suspended from a bracket above and serving to keep the spindle *L* hard up against the end of the groove in the former plates *K*. These master plates, of which there are 26, one for each of the grooves in the brass plate *A*, are located by dowels and fastened in turn to the front of the base plate by means of two adjustable clamps *Q*, Fig. 3. These clamps are so arranged as to take in the different former plates by the changing of the location of the clamping screw *R*, the final clamping being accomplished by forcing down the levers *S* which tighten the clamps *Q* through the cam formed on the end of the lever. With this design of clamp the former plates can be quickly removed and others inserted. The former plates are equipped with a hardened-steel plate *T* which is screwed down in position by two small screws, and by the use of these plates the correct angle and curve are retained. Each former plate has a letter which represents one of the characters of the alphabet; the one shown in Fig. 3 is designated as *P*, and when in use the stud *I* of Fig. 2 must be located in the hole marked *P* in Fig. 4. It will be seen that it is a simple matter to locate the stud correctly.

Particular attention is drawn to the method employed for locating and clamping the brass casting *A* in position for machining. Before the casting is milled it is ground on the face *A'* and drilled through the two lugs *U*. After this operation it is set in place on the uprights *V* and accurately located by the two small pins *W* which enter the drilled holes in the ends *U*; the casting is then firmly clamped down by the turning of the two levers *X* to a vertical position, as shown in Fig. 5. These clamps are so set as to allow the clamping fingers *Y* to be forced out at the lower end by the cams *Z* as the lever *X* comes to a vertical position. When the levers are released the flat section of the cam *Z* will allow the fingers *Y*, which are heaviest at the lower end, to swing in so that the casting *A* can be readily removed.

In Fig. 6 can be seen two of the former plates representing slots *A* and *P*, and the position of the grooves will be observed to correspond to those shown in Fig. 1.

In operation this device first drills and mills one particular slot in a small batch of work, and in this way the 26 slots are machined. The lower ends of 18 of these slots are slightly enlarged for the purpose of inserting the type bars; this enlarged opening is produced by the same mill being forced to follow around the edge of an enlarged portion of the groove in the former plate.

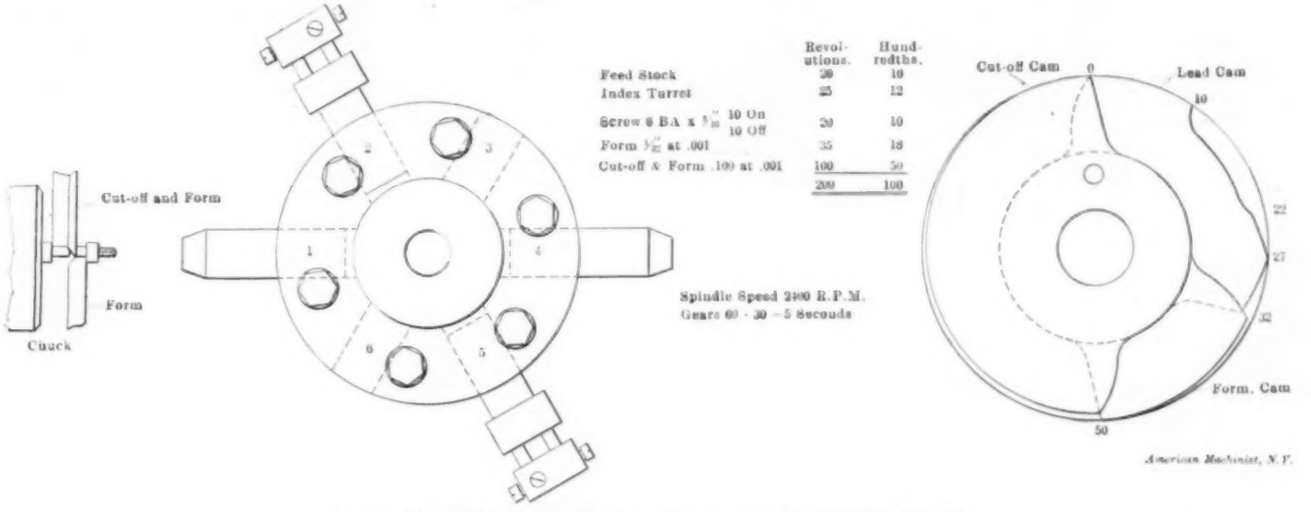
Newark, N. J. JAMES G. SPERRY.

Making a Small Stud on the Automatic Screw Machine

In getting out the data for a set of cams to make a small brass stud, as shown in the sketch, on a No. 00 Brown & Sharpe automatic screw machine, the number of revolutions came out at 200, which, with the spindle running at 2400 revolutions per minute, would make the piece in 5 seconds, 1 per cycle, and on the face of it, the job appeared to be one that should be done 2 per cycle. I had decided to use the "form and cut-off" method as for short work, so I only needed a stop and die holder in the turret.

But I do not advocate the two per cycle method, as in formed work you have to rely on one set of tools, and there being two lobes on the forming cam, any variation in these two lobes is increased two-fold on the work. For instance, if there was a difference of 0.005 inch between these two lobes there would be a difference of 0.010 inch in the two pieces made in one revolution of the cam shaft.

In my data there was only time allowed for indexing the turret one hole, so that while forming and cutting off, the turret had to be indexed five times, and on a job of this kind, this looks to be a bit hurried. So I made my cams one per cycle and when I set up the machine, I put two sets of tools in the turret, and took off three of the dogs for revolving the turret. Using my first set of tools in holes 1 and 2 (3 being empty) I made my first piece, the turret indexing three times and making one-half a revolution to one of the cam shaft.



TOOLS AND CAMS FOR MAKING A SMALL STUD ON THE AUTOMATIC

By this time the stop in my second set of tools in holes 4 and 5 (6 being empty) was in position to feed stock to make a second piece, thus the turret made one revolution to two of the cam shaft. This method has much to recommend it, as it saves the wear and tear of the mechanism for indexing the turret and in the case of a screw that has to be picked up and slotted, no special cams are necessary. the standard cams for slotting one per cycle can be used. This cannot be done on the old pattern machines with five holes in the turret.

London, England. J. V. O.

An Improved Friction Clutch

The friction clutch described below was used in the design of a turret lathe and proved to be a big improvement over similar clutches in use on other lathes in the shop.

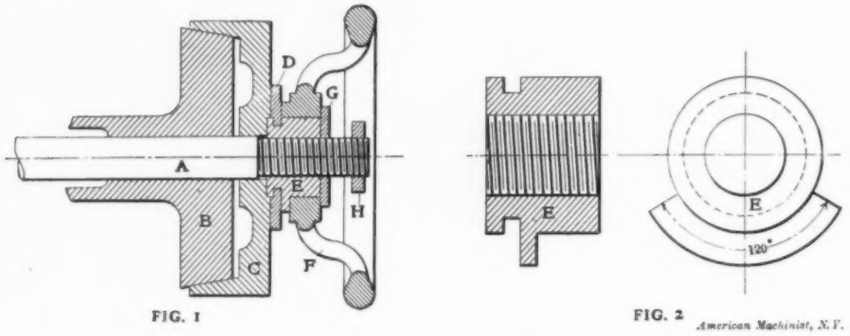


FIG. 1 FIG. 2 American Machinist, N.Y.

AN IMPROVED CLUTCH

In Fig. 1, *A* is the clutch shaft which carries a worm wheel on the end not shown in the cut. This worm wheel meshes with the feed screw under the turret carriage. It also has a thrust bearing to take care of the end thrust when the clutch is tightened. When the clutch is tightened the worm wheel, being held from turning, acts as a nut and feeds the carriage. When the clutch is loose, the shaft and worm wheel simply revolve and the carriage remains stationary.

B is the sleeve in which the shaft runs and is bolted fast to the carriage. It has the male half of the friction on its end, as shown. *C* is the female half of the clutch, and is free to slide on the shaft, but is prevented from turning by a key not shown. *D* is a retaining plate fastened to *C* with machine screws to make it follow the nut, whichever way the latter moves.

E is the nut which turns on the threaded portion of the shaft. The thread is of such a hand that when the clutch is locked the torque from the feeding of the carriage will tend to tighten the clutch. With the clutches in general use, this nut is simply a part of the hand wheel, and it is here that we have made our improvement. The nut is shown in detail in Fig. 2. It is a simple round nut with a groove in which the retaining plate *D* runs and has a radial lug taking in an arc of 120 degrees.

F is the hand wheel, which is bored to rotate on the nut *E*. This wheel has a lug on the side of its hub exactly similar to the one on the nut. When the two are in place we have a finger clutch in mesh, but with 120 degrees of play. Unlike a finger clutch, it cannot be thrown out as it is fitted with a retaining plate *G* to prevent this. *H* is a set nut to adjust for the amount of movement in the nut.

In using the clutch the hand wheel is first moved the 120 degrees to take up play when the lugs come into contact and the clutch tightens. Here there is nothing gained over the old style. In releasing the clutch we have the 120 degrees of lost motion to take up and this gives a momentum to the hand wheel which releases the clutch at once.

With the old-style clutches in use on some of our machines it is frequently necessary to use a pipe in the hand wheel as a crowbar in order to loosen things up. This has happened at critical times, causing spoiled jobs, broken tools and much strong language. With the new turret lathe the clutch is easily released with one finger.

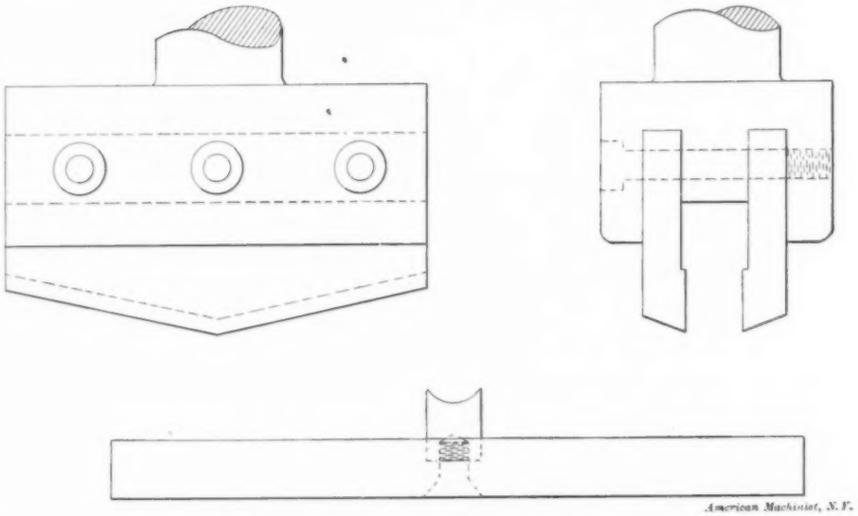
Our only fault with the new clutch is that since we have installed one of them every man in the shop using a clutch wants this kind of a one, and seems to feel that he is being discriminated against. The principle of this clutch has since been applied successfully on several other hand clutches which had acquired a habit of sticking.

Milwaukee, Wis. JOHN BAILEY.

A Milling Operation Done on the Punch Press

The accompanying cut shows a punch and die I designed a few years ago to slab the flat sides of automobile-tire valves. As most readers of technical journals are familiar with automobile-tire valves, it will be necessary to give only a short description of what the tool, shown, had to accomplish; that is, to slab two flat sides on a brass tube internally and externally threaded and leave a wall between the bottom of the internal thread and the flat sides less than one-hundredth of an inch thick; to make a smooth surface and not mar the thread (28 per inch) in any way. It also had to leave the inner threaded hole perfectly round, as a valve has to stand 100 pounds air pressure, therefore, the valve seat proper has to be pretty near perfect. Previously this work was milled on hand-milling machines with straight-faced spiral mills, machining one side at a time, side or straddle milling being out of the question, owing to the burs left on the threads.

The die proper is composed of a steel punch holder, made to hold two hardened and ground jaws made to cut like shears, and rigidly held in position by screws, making it an easy matter to take apart to resharpen. The under cut on the jaws is for the reception and easy extraction of the work when punched.



THE PUNCH AND DIE FOR THE MILLING JOB

The punch consists of a piece of steel bored to fit the diameter of the valve and machined to the desired thickness of the finished work, the sides being equidistant from the center and fastened to an iron plate for clamping to the platen of the power press. This style of punch and

die can be modified to do a variety of different milling operations and at an enormously reduced expense. The punch and die here described, operated by a girl, did the work in five hours that it took four hand-milling machines and four men to do in nine hours.

CHARLES J. COLLIGAN.

Brooklyn, N. Y.

A Riveting Device

While ordinary riveting is as old as the hills, we occasionally come across some novel riveting devices. The device shown in the accompanying sketches was designed to perform the riveting of a ribbon spool for a typewriter. The spool which consists of three pieces, is shown in detail in Fig. 1, a disk and die hub blank being there designated as *A* and *D*. It will be noted that the center section or hub has eight small projections or tits *B* and *B'* on its edges which, after the hub has been formed into a circle, fit in the small slots *C* of the disk *D*; it is at this stage of the assembling that the riveting device is brought into play, the operation being accomplished on a press.

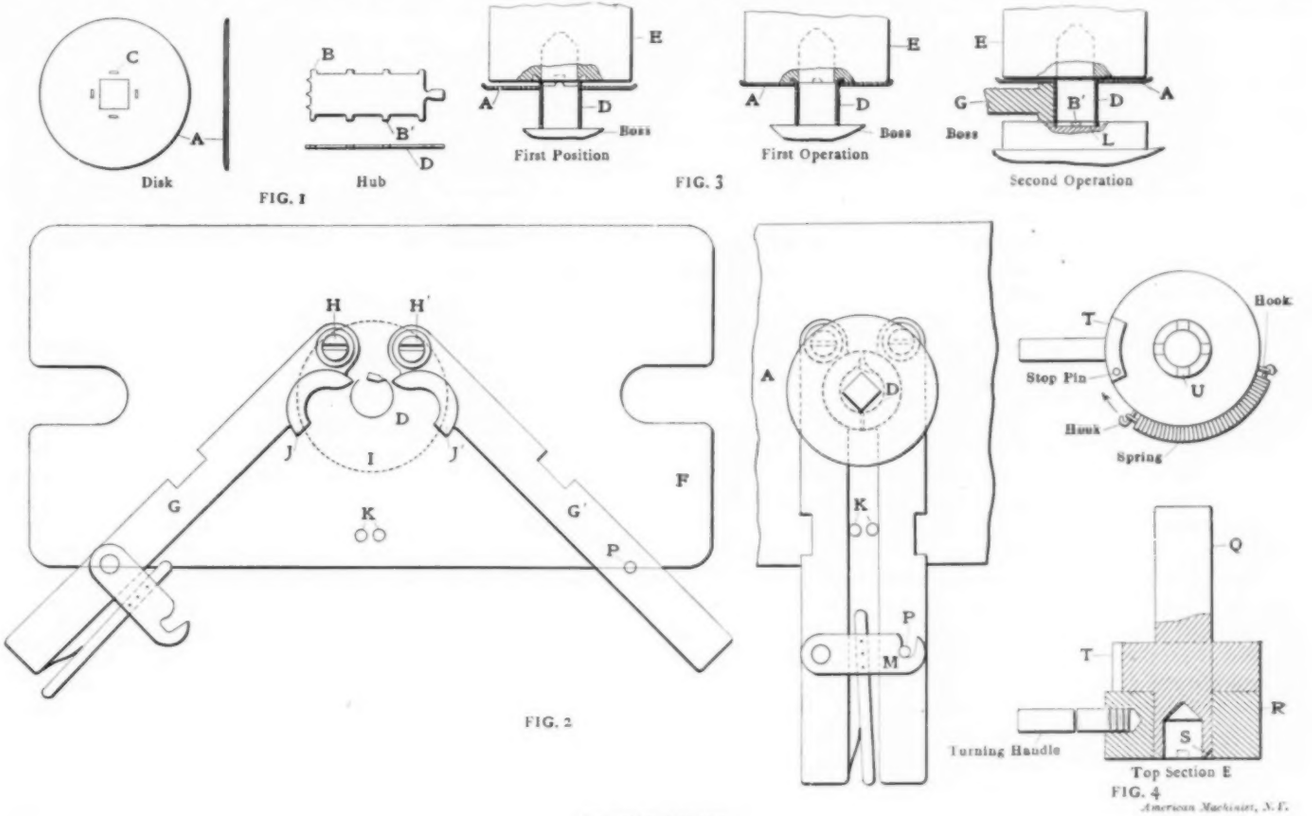


FIG. 1 FIG. 3 FIG. 2 FIG. 4

American Machinist, N.Y.

RIVETING DEVICE

Mounted upon the base plate *F* are the two clamping arms *G* and *G'*, Fig. 2, which pivot from the two screws *H* and *H'*. Upon the inside of these two arms, a short distance from the pivoting screws are two semi-circular jaws *J* and *J'*, which support the disk and hold the hub of the ribbon roll in a central position on the face of the boss *I* of the base plate. These arms are prevented from passing the center by two pins *K*, which can be seen in Fig. 2, where the arms are shown in both open and closed position. The arms are held in a central position, when closed, by a latch *M*, while attached to the latch is a small extension that strikes against a spring which forces the latch around the locking pin *P*.

To facilitate the placing of the hub *D* in a central position, a small groove 1/16 inch deep and of the same diameter as the hub, is made in the face of the boss *I*, as shown at *L* in the sketch representing the second operation in Fig. 3. In this same sketch is shown a section of the arm *G*; it will be noted that the hight of the jaws is just sufficient to allow the riveting of the tits *B* without bending those at *B'*, as all strain comes on the top surface of the jaws.

Particular attention is drawn to the top section *E*, shown in detail in Fig. 4; it is by the use of this that the device is made very valuable, as it really performs two operations consisting of bending and riveting which are shown as the first and second operations in Fig. 3. This device, Fig. 4, consists of two parts designated as *Q* and *R*. While one end of *Q* fits in the press the other end passes through a hole in *R*; on the latter end is a bevel of 45 degrees which is shown at *S* in Fig. 4. It is this bevel that forces the tits over, which operation is followed up by the operator giving *R* a turn by the handle in the direction of the arrow until the stop pin hits the end wall of the slot *T*. The tits will then be in between the four small pockets *U* that formerly received them, where the final riveting is accomplished. This can be seen in the second operation, Fig. 3. Upon the completion of one end of the roll the spring on the side of the upper device will pull the ring *R* back to its former position ready to attend to the other side of the roll.

Princeton, N. J. GEORGE LAKE.

A Shop Test of High-speed Steel

In the shops of the Ball Engine Company, in Erie, Penn., I saw the shop test which they apply to every bar of high-speed steel which is bought. The acceptance of the steel rests with the result of this test.

A tool is forged from each bar and is marked so as to be easily identified. There are certain pieces which enter into the manufacture of the engine which are made in large quantities, and there are always some of these in the rough state ready to make the test. The lathe is speeded up to 225 feet per minute and a rough piece is placed between the centers. The cut is then started 1/8 inch deep with 1/8 inch feed. If the tool stands up for the full length of the cut, about 18 inches, the bar is accepted. If it fails the bar is returned to the maker. I am told that the tools either hold up indefinitely at this enormous speed or fail within the first few inches.

New York. E. A. DIXIE.

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Critical Points in Carbon Steels

In Volume 32, No. 6, page 215, of the AMERICAN MACHINIST, W. Osborne asks for information as to "Where in relation to the critical points should steel be heated for the best results in hardening?" In other words, how high can the steel be heated above the so-called recalescence point without injuring the steel? My experiments along the steel line have taught me that the carbon contents have a big say so, as to what the steel will do under proper treatment, but carbon is not all, for carbon never made poor steel good. Some steels high in carbon may make good butter knives, that is, if the butter is soft, but we will take it for granted in this article that all the other properties that go to the making of good steel are in the steel, in the proper proportion, and the steel is good steel.

We will begin on the so-called recalescence point. This is the point at which a stay or stoppage of the heat occurs. The checking of the heat in high carbons is quite easy to see. I call this point the transition point, for it is at this point the change commences and King Carbon begins to assume his control over the ferrite. At the true recalescence point he relinquishes his grasp as a hardening agent and ferrite comes into its own again. When the scleroscope came out the writer did not look upon it with much favor, but since then I have had some experience with it and find I can locate these points on a piece of steel after heat-treating it.

Mr. Osborne says of the critical points: "These points are quite a distance apart in iron while in steel they are close together," but they are close together in carbon steel in proportion to their carbon contents. For example, in a test made with 0.35 per cent. carbon steel, the transition point occurred at 1357 degrees Fahrenheit; the heat was checked slightly at this temperature, and although the heat (by gas) was being pumped into the furnace, a flattened curve was produced on the recorder, which continued through 34 degrees Fahrenheit of heat. The line then straightened out and ran up until the gas was shut off, after which the line descended to 1269 degrees Fahrenheit, where the true recalescence point occurred. At this point the line went up about 2 degrees Fahrenheit in reheat, then it dropped down to 1200 degrees Fahrenheit where the pyrometer was taken out. There was 88 degrees Fahrenheit between the two points.

On a piece of steel containing 0.9 per cent. carbon, the transition point was the same, 1357 degrees Fahrenheit, while the recalescence point was reached at 1330 degrees Fahrenheit. The action was the same as on the 0.35-per cent. carbon steel, but at the transition point the check was greater and the curve was smaller and fuller, and it took but 15 degrees of heat before the line was straightened out. At the recalescence point the reheat was about 3½ degrees, and it then descended as on the 0.35 carbon steel.

On tests of steel containing 1, 1.25, 1.35, 1.50 and 1.65 per cent. carbon, the transition point remained about the same as above, but the heat was checked and the check was more pronounced, the higher the carbon contents. The higher the carbon the smaller and fuller the curve and the greater the check in heat until you get (if you go high enough in carbon) a steel that will not stand quenching in water. Steels with a carbon content of 1.75 and 1.65 can be quenched safely.

The higher the carbon contents the closer the transition and recalescence points are together. There is a carbon so high that it cannot be hardened because there is no space left between the transition and recalescence points for the chemical lag to work in. It is a well known fact that the chemical action does not take place as quickly as the rise and fall of the temperature. In some high-carbon steels the line will straighten out after making a curve through 5 degrees of heat. It is the steels with a carbon content of but 2 degrees and less that give trouble, but these you do not want for tools.

If W. Osborne will take a piece of carbon steel, the transition point of which is 1357 degrees Fahrenheit, the curve 9 degrees Fahrenheit, and the recalescnce point 1346 degrees Fahrenheit, there will be a difference of 20 degrees between the point where the line straightened out and the recalescence point. Add this 20 degrees to 1366 degrees, the point where the line straightened out, and he will have 1386 degrees, the point to take this steel to. There will be no danger of overheating, and he will have a fine, hard, flinty grain. Any farther up is a waste of gas and steel. I do not say it will not harden at a lower temperature, for it will, and besides he is not asking about low temperatures, but about critical points.

The reason I added the 20 degrees is, that the grain at 1366 degrees is a refining grain as it is called, and while the transition has taken place it has not had a chance to alter the structure of the body. The addition of 20 degrees is, therefore, necessary to alter the grain to a flint. You may think when I say flint that it is but a short distance from crystallization, but you may be wrong, although I will admit there is not a mile to go. By the scleroscope, you have lost about 1 per cent. in hardness, but have produced a grain that will cut, and that is what you are after.

I have found since using the scleroscope that the old blacksmith method and theory of "a little heat is good, a little bit more is better," has been exploded, as a little bit more means a loss in hardness for the tool, although it cannot be detected with the file. A piece of steel containing 150 per cent. carbon will show around 110 on the scleroscope scale, if hardened properly, but that same steel will resist the file if heated up to 1800 degrees Fahrenheit, while it has lost about 45 per cent. of its hardness. No one in his sober senses would undertake to harden this steel at 1800 degrees, but if the steel has been over-annealed at the steel mill, it will not harden on the surface at the low temperature this carbon content calls for, and, therefore, the hardener gives it a little bit more heat. I use the scleroscope to detect this over-annealing and govern myself accordingly.

As Mr. Osborne says, "the quicker the heat can be extracted the harder the steel." Let me do a little comparing. Take two glasses, each holding one gill, and fill them half full of vinegar, then take as much soda as you can lift on the point of a penknife and put it in the first glass; for the second glass put in as much as you can lift on the point of a butter knife and note the results. The first will represent 0.90 carbon, the second 1.65 carbon, and I think you will find a difference in their action.

Now compare water and steel together; water boils at 212 degrees Fahrenheit; let there be 1 quart, or a wash-boiler full, but bulk becomes a factor as time enters into the field for our consideration. The same holds good in steel, the transition point remains the same, 1357 degrees Fahrenheit; let it be high or low in carbon, but the high carbon takes hold quickly, or takes less heat to complete the transition. If the steel is low in carbon it takes more heat to send the low carbon through the mass of ferrite as I pointed out with the vinegar and soda, and the low carbon will not crystallize as quickly nor as much as high carbon. The higher in carbon the more pronounced the crystallization in going above the critical point.

There is one point in hardening that is

not given the attention it should have and that is heating slowly up to about 1100 degrees Fahrenheit, and from there to raise heat more quickly to the heat required. I don't mean by that to put the steel in a furnace, the heat of which is around 1650 degrees, while the piece you want to harden should go only to 1400 degrees. That is the way it is generally done, however, and that is the cause of so many failures in hardening.

In heating steel the heat acts first on the surface; this expands and pulls away from the inner body, and if the heat has been quick, the strain is great and causes a weakness within the steel that shows up when the chill of the bath takes hold. The piece, may and often does, crack in chilling, but if it stands the pressure of the bath this weakness may show up later in a fracture of the tool and a complaint that the tool was not drawn enough. All the drawing you could give it would not restore this lost strength.

Pittsburg, Penn. FRANK GEORGE.

Boring an Ellipse on the Milling Machine

At page 702, Vol. 30, Part 2, there appeared an article in which the writer, A. F. Shore, described his experiences in making an elliptical die of perfect curvature. He set the die vertically in the milling-machine vise, put a fly cutter in the vertical milling attachment and tipped up the head through a certain angle to get the required difference of diameters. To get the angle he constructed a right triangle, the hypotenuse representing the long diameter and the side adjacent the short diameter and measured the angle between them. This is the angle at which the milling head was set from the horizontal. It would have been easier and more accurate to obtain this angle mathematically, simply dividing the short diameter by the long diameter, the quality thus obtained being the cosine of the required angle.

Angle.	Cosine.	Angle.	Cosine.
½°	0.99996	15½°	0.96363
1°	0.99985	16°	0.96126
1½°	0.99966	16½°	0.95882
2°	0.99939	17°	0.95630
2½°	0.99905	17½°	0.95372
3°	0.99863	18°	0.95106
3½°	0.99813	18½°	0.94832
4°	0.99756	19°	0.94552
4½°	0.99692	19½°	0.94264
5°	0.99619	20°	0.93969
5½°	0.99540	20½°	0.93667
6°	0.99452	21°	0.93358
6½°	0.99357	21½°	0.93042
7°	0.99255	22°	0.92718
7½°	0.99144	22½°	0.92388
8°	0.99027	23°	0.92050
8½°	0.98902	23½°	0.91706
9°	0.98769	24°	0.91355
9½°	0.98629	24½°	0.90996
10°	0.98481	25°	0.90631
10½°	0.98325	25½°	0.90259
11°	0.98163	26°	0.89879
11½°	0.97992	26½°	0.89493
12°	0.97815	27°	0.89101
12½°	0.97630	27½°	0.88701
13°	0.97437	28°	0.88295
13½°	0.97237	28½°	0.87882
14°	0.97030	29°	0.87462
14½°	0.96815	29½°	0.87036
15°	0.96593	30°	0.86603

TABLE OF COSINES.

Mechanics are not generally familiar with trigonometrical functions, so, for the sake of the uninitiated I append a short list of cosines for angles from ½ degree to 30 degrees. I may state that the method is simply to divide the short diameter by the long diameter as before explained, find the quantity thus obtained (or the one nearest to it) in the second column and set the machine head at this angle with the work, not forgetting, of course, to set the cutter in the bar to the *largest* diameter of the ellipse.

This is an excellent and economical method, but it has many limitations. It is not advisable to drop the cutter head more than 30 degrees and for this reason it is difficult to cut an elliptical hole having a ratio between diameters of more than 5 to 4. If great accuracy is required a complete table of cosines should be consulted.

Montreal, Canada. W. H.

Should a Machinist Leave His Machine Running While Away From It?

W. L. McL.'s article, on page 748, brings up a subject which has been the source of many troubles and to which it is hard to give a definite answer. Taking it from the employer's point of view, we may ask, where is the foreman or superintendent who is willing to take chances, sometimes with a newly hired man, and risk ruining a $10,000 machine tool for a saving of, let us say, putting it at a maximum, 50 cents per day. It is not only the work on the machine which is liable to suffer; the machine itself may be put out of commission.

Several years ago I was employed by a French machine shop at the marking bench. Just behind me was a heavy Ingersoll milling machine milling street-car motor frames and taking three cuts simultaneously. Everything being started in fine shape, and the cut to last, at least, half an hour, the machinist took a walk to the casting yard in order to get the next lot of castings. When he came back his machine was little short of a complete wreck, and this is about what happened. He had left the wrench he used on one of the clamping nuts on top of the fixture. After a while, it struck an oil shield, which fell. We heard it, but didn't pay any attention to it, as so many things fall in a shop. A few instants later the teeth of the driving gears, between the electric motor and machine, gave way and were thrown all around. One fell in the small motor, driving the feed, and made a short circuit between the housing and the brushes. Before the gears gave way, the wrench had been caught between a milling cutter and the fixture, which being strongly built, the arbor had to bend, its bearings followed the movement, and one broke under the strain. The bevel gears driving the arbor broke to pieces, bending one or two other shafts, etc. In a word, besides the small motor, of which the commutator, brush holder and brushes had to be replaced, there was a repair bill of almost $500, and a machine idle for two months, no spare parts being available, and everything having to be sent for to America. If the man had been where he belonged, the oil shield, falling, would have called his attention in time to stop the miller and prevent any further disaster.

Another time, a lathe hand left his lathe working on a shaft having a large shoulder for coupling purposes. Coming back, he found the foreman looking, with evident interest, at the broken upper slide of the carriage and the buckled feed screw. Similar examples may be cited in large numbers; anyone having had relations with a shop may give you twenty cases where the presence of the workman at his machine would have prevented breakage, or accident.

A case of the latter happened in a shop where I was employed in this country. A toolmaker was working on a shaft grinder. He had to grind a long shaft with a collar in the middle; after starting the machine, he thought he had plenty of time to get a drink before the first cut would be finished and went to the fountain. The first one being empty, he went to another room. While he was gone, the automatic stop did not work in time, the wheel came against the collar and burst. Another toolmaker was struck by a piece, which gouged out one of his eyes and part of the nose. I do not know what became of him, but I would not be surprised to hear that he is now blind. The shop being in Pennsylvania, he had no redress against the employer, and even if he had, would it have been just for the employer to pay?

There are so many accidents that can be traced back to the same source that it seems strange that anybody tries to justify the habit of leaving a running machine, not built to work alone, for automatic machinery is in another class. The employer may gain a little by letting the workmen leave machines in motion, but there should not be, in any shop, 10 minutes lost out of 60, for errands not connected with the work. A man has no business to lose one hour a day for the purpose of having a drink. As to the item of sharpening tools, the manufacturer who desires to cut down lost time, would do much better by having all tools ground in the tool room by a specially appointed machinist, and the tools would, in general, give better results.

Everybody knows that a man cannot work ten hours a day without some moments of rest, and if he does not take

them when going to the tool grinder or for a drink, he will take them some other time. Often the real reason why a machinist leaves his machine running, while gone, is not to save a few minutes for his employer, but because the foreman, though not seeing him at his machine, will think he is gone only for a few instants on an emergency call and will not be long before he is back; while, if the machine is stopped, an investigation may follow, always a disagreeable thing, for you are always discovered where you should not be, doing what you should not do. Then, there is also the feeling among the foremen that the fellow who runs chances has more blood and nerve than the one who does everything with the fear that an accident may happen. It is good to be careful, when carefulness does not become a handicap; a little carelessness may very often do no harm, but it is not safe.

One cannot say that it is without good reasons that almost every shop has in its rules one forbidding the leaving of machines running without an attendant. Fads do not last long in machine shops, and we must think that if the majority of them agree on a point, that point has been found to answer the requirements.

Lynn, Mass. P. FENAUX.

Welding Boilers

On page 291 of the present volume of the AMERICAN MACHINIST, the article entitled "Electric Welding in the Boiler Shop" gives a comparison of the cost of boilers that were riveted and welded by electricity, and oxy-acetylene.

In this electricity is shown to be the most economical, but this does not seem fair as the figures taken for electricity are, no doubt, from a large number of welds made on the most uptodate machine than can be devised for the work, and apparently the figures for oxy-acetylene welding have been taken from hand work, probably the result of welding one or two boilers.

Though I do not wish to infer that I think the oxy-acetylene would be the best for this purpose, I think it is unfair to make a comparison in this way, as machinery can be devised which would weld this up by means of the oxy-acetylene flame at a very much less cost than the figures given. There is no reason why the flame should not be held stationary and the work passed under it in the same manner as in the electric welding, and I see no reason why a sufficient length of flame should not be provided to accomplish the work in practically the same length of time as that taken for electric welding.

The cost of the gases would, of course, be more than the cost of the current, but when one considers the cost of the equipment that is necessary for electric, which in the majority of cases would include special means for generating the current, or at any rate a transformer, the oxy-acetylene equipment would be more suitable for many conditions than the electric equipment.

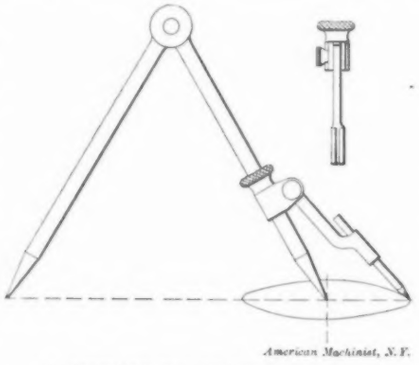
Machine welding by means of the oxy-acetylene flame is being carried out to a considerable extent abroad, and there are a few cases of its use in this country, particularly the welding of the new Edison battery jars which are made from nickel iron; the longitudinal seam being welded in one machine, while the bottom and top are welded on in another machine. This machine automatically feeds the jar along the four sides, and turns each corner in a very neat manner so that the flame plays for a uniform period throughout the job. The top is welded in after the battery plates are assembled in the jar, the whole thing being welded together.

Springfield, Mass. HENRY CAVE.

A Compass for Drawing Ellipses

The sketch shows a useful arrangement for accurately drawing ellipses by means of an attachment adapted to fit the circular leg of an ordinary pair of dividers, and which can be easily made by an experienced machinist without requiring special tools.

Briefly, it consists of a sliding sleeve to which is attached a pen or pencil holder, or even a scribing point for marking metals. This extra leg is hinged to the sleeve in such a way that it can be adjusted to any size ellipse within the capacity of the dividers, and can also be clamped when set by means of the milled screw shown. The attachment may be of



A COMPASS FOR DRAWING ELLIPSES

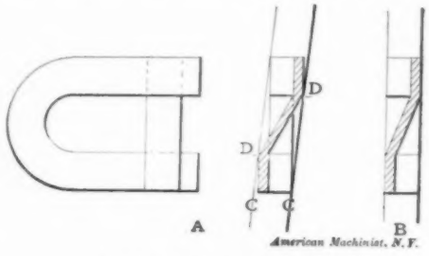
any serviceable metal, but the one shown here is of gunmetal, the dividers, also homemade, being of forged steel.

To use the instrument the center lines are first drawn and on these the lengths of the major and minor axes are marked off. The point of the leg to which the sleeve is fitted is then placed in the center where the axes cross, and with the leg held vertical the pencil is adjusted to the smaller radius and clamped in position. The free leg of the dividers is now extended along the line of the major axis until the pencil reaches the point already marked off, and by turning the sleeve and at the same time allowing it to slide up and down with the pencil in contact with the paper an ellipse is drawn. Simple as this device is it will be seen that its action causes it to describe a true ellipse, i.e., an oblique section of a cylinder.

London, England. S. J. P.

A Handy Bending Form and Cutting Internal Gears with a Slotting Attachment

On page 443, Roy H. Grove gives a sketch of a bending form, in which I think there is room for improvement, as a blow under the steam hammer would not produce the work as he has drawn it. In the sketch at *A* I have reproduced his figure adding two lines *C C* to represent the hammer faces. From this it will be seen that the material will be unduly stressed at *D D* without bringing down the outside. If the form is made as shown in the end view *B*, either by machining or by a twist, the hammer will bring the job down flat.



A HANDY BENDING FORM

I was interested in the slotting attachment shown on page 445, because we have been using a similar rig for slotting some steel annular gears, with 90 teeth 20 pitch, and the arrangement answered very well. There is one point in connection with this kind of rig that should not be overlooked, that is the stop limiting the depth of the cut should always be placed as shown, i.e., central, and should be very stiff. More especially is this so when employing semi-skilled labor. The position chosen by Mr. Cloburn is probably the best and handiest position on the machine. The tool shown is rather a poor one for slotting, and I should anticipate that in slotting 12-pitch teeth in steel it would move, unless the sides of the cutter were serrated, or some provision made for securing it other than by the center bolt. It would be interesting to know if any trouble was met through this cause, and if so, how it was met. One great drawback to this style of cutter for slotting is the large amount of clearance required. In speaking of the cutter Mr. Cloburn says, "This is, of course, turned the same profile as on an ordinary gear cutter of the same pitch, etc." This is, of course, a mistake as the profile of the tool for an internal gear is the opposite to that of an ordinary gear cutter.

WALTER G. GROOCOCK.

Woolwich, S. E., England.

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The National Association of Manufacturers and Industrial Education

We have been greatly disappointed at the outcome of the long discussion of industrial education before the National Association of Manufacturers as shown by the report of the special committee of the association to which we have already referred in our report of the recent convention, as well as by the resolutions adopted at the convention.

The report of the committee is to the effect that the movement toward a great system of industrial education is going forward so satisfactorily that not much remains for the association to do.

It is quite true that a large degree of interest in this subject has been shown, not only at the annual conventions of the Society for the Promotion of Industrial Education, but by discussions before associations representing various employers' interests as well as by numerous articles in periodicals, but of effective work done, in comparison with what needs to be done, there has been but little and we do not believe the time has come for any association to rest its oars with respect to the subject.

Out of all this discussion two tangible things on which one may place his finger and say "here is progress" have developed. These are the shop-school apprenticeship system with a qualified trade teacher as developed by Mr. Alexander, at Lynn, and adopted in a few cases elsewhere, and the coöperative system of Professor Schneider, which, as practiced by him, relates to engineering and not industrial education, but which, in his opinion and in our own, has equal application to the latter field to which it is, in fact, being applied in a few cases, notably at Fitchburg, Mass.

These two plans have now fairly cracked their egg shells and struggled into life. The number of actual applications of both can be counted on the fingers of one hand. They are just in that state when they need concerted effort to bring about their wide adoption, this of all times being the last when the Manufacturers' Association should discharge its committee and go to sleep.

Perhaps, however, the most discouraging feature of the situation is found in the resolutions adopted which call in the usual perfunctory manner for the incorporation of industrial education in the public-school system, in which the members of the association are to coöperate. Our belief is that if manufacturers are to wait for the public, with or without coöperation, to supply them with skilled workmen through the operation of trade schools supported at public expense they will wait until the crack of doom.

It is true that the public has a general interest in this subject, but nevertheless a very limited interest compared with that of manufacturers, whose interest grows out of their very real need of more skilled workmen than they can find.

If manufacturers need skilled help we believe it to be their duty to train that help and not throw the burden upon the public-school system where it involves an outlay that staggers the imagination and where the work cannot be so well done as in the factories, provided the teaching of apprentices which is now almost ignored be properly attended to.

This call for a system of trade schools supported at public expense when made by manufacturers is nothing but a demand that the public shoulder the burden of a system of schools whose cost is appalling in order to save them the trifling expense of suitably qualified trade teachers.

That this country will ever see a great system of trade schools incorporated into the public-school system and including a lot of miniature factories in which trades are taught, when, with the simple addition of shop teachers, the work could be infinitely better done in commercial factories and the boys earn something while learning, we do not believe. No doubt experiments of this kind will continue to be made, some of which will be successful and certainly we admire the public spirit of any community which undertakes the work, but the solution of the problem does not, we believe, lie in this direction.

In comparison with what has been done by the Machine Tool Builders' Association and the Metal Trades Association the action of the Manufacturers' Association is nothing less than discreditable. The action of the Metal Trades Association in appropriating money for the support of the Winona Technical Institute is still fresh in our readers' minds, while the activity of the Machine Tool Builders' Association in developing an organized apprenticeship system cannot have been forgotten.

Those associations have not called upon the public to shoulder their own burden, nor have they confined their activities to talk. On the contrary, they have recognized that their own interest in the subject is paramount, that it is for them rather than for the general public to act, and they have taken action.

We would not be understood as saying that the public-school system has no part to play in this movement. On the contrary, it has such a part and one to which it alone is adequate. That part is the one now undertaken by it in Fitchburg, where it is to conduct class-room work of a kind adapted to the future occupations of the pupils, work which is strictly analogous to that done by the German continuation schools. This work is not, however, the teaching of manual skill and dexterity, which can be done in factories far better than it is likely to be done in school shops and at a small fraction of the cost.

Will There Be Enough Machinists?

Those who are looking ahead to a continued revival of business in the machine-tool line are not altogether pleased with the prospect of obtaining a sufficient number of skilled mechanics when that time arrives. While this seems very strange at a time when we know that many are out of work at their old shops, close observers assure us that there is by no means a good and sufficient supply of men in sight. In fact, we know of a few instances where men have had to be sought to increase the force toward its normal capacity, in one case by advertising in another city.

The explanation is that the men have been forced to leave the machine-tool centers and have drifted into other lines, such as agricultural machinery and the automobile shops, where the business has been good almost without exception, and some are wondering whether it will be easy to get the men back when they want them.

There seems to be a certain fascination in the building of automobiles that attracts mechanics besides the usually good pay and, in many cases, the excellent shop conditions that exist. Then, too, the fact that few apprentices have been trained in the last two years tends to make a shortage of young mechanics, and active steps are being taken in some quarters toward giving special attention to this end of the question in view of the increasing business that is sure to come, and perhaps sooner than we think.

In some respects the machine business can be compared to the farming communities where the soils have been worked year after year without much attention to replenishing the elements necessary to make it fully productive. So the crop of machinists has been used in some quarters with little attention to training new ones, and as a result the carefully trained mechanics are not as numerous as they should be for normal times.

Some of the automobile shops have been rank offenders in this line, drawing men and boys, even partially trained, away from the older branches of the trade and doing little or nothing to train new men, even specialists on one or two types of machines.

While there is probably less demand for the all-around machinist than existed a few years ago, there are still more places where they would be appreciated than might be imagined. It is a mistaken idea to think that all work is done in jigs and fixtures, even in the large and uptodate shops. There are still many places where skilled work, good judgment and a practical knowledge of more than one machine is necessary and in demand.

The only way to supply this, to be ready for any emergency, is to make a business of training boys thoroughly, fairly, and as humans, not as pieces of machinery. And now is a good time to begin.

Semi-Annual Meeting of the National Machine Tool Builders' Association

The semi-annual meeting of the National Machine Tool Builders' Association was held at the Plankinton house, Milwaukee, Wis., on May 25 and 26. The attendance was surprisingly large in view of the fact that there was no other attraction as is the case at Atlantic City, 55 machine-tool builders being represented, a few more than last year.

The sessions were largely devoted to committee work by manufacturers of various tools, following out the ideas of the association tending toward a greater uniformity of product and capacities of machines.

William Forsythe read a paper on "Machine Tools for Railroad Shops," pointing out the reasons for their failure in many cases, to adopt the best machinery, but showing how this was being remedied and better results secured.

A very gratifying feature of the meeting was the general tone of optimism and the reports of increasing business in nearly all lines of machine tools. With very few exceptions there was a unanimity of opinion that the business outlook in this line is very hopeful and gratifying.

Francis X. Pund

Francis X. Pund, vice-president of the D. T. Williams Valve Company, died on May 8, after a brief illness.

Mr. Pund was born in Cincinnati, O., 58 years ago. He entered business at an early age, and in 1904, after a long and successful career, he entered the manufacturing business with David T. Williams, and thus founded the large firm in which he took an important part up to the time of his death. Mr. Pund acquired considerable prominence as a member of various business organizations, and is survived by his wife and three children.

New Publications

DES INGENIEURS TACHENBUCH III, HERAUSGEGEBEN VOM AKADEMISCHEN VEREIN HUTTE. 20th Edition; 795 4½x7⅛-inch pages; 780 illustrations; indexed. Wilhem Ernst und Sohn, Berlin. Price (three volumes) 17 marks in linen binding, 20 marks in leather binding.

On page 714 we reviewed the first two handbooks of which this is the third and last of the set. It applies to construction work, or perhaps somewhat inaccurately, to civil engineering. There are 15 sections with the following titles: Surveying, 58 pages; Superstructures, 62 pages; Ventilating and Heating, 20 pages; Roadbuilding, 37 pages; Domestic Water Supply, 33 pages; Public Water Works, 30 pages; Statics of Structures, 86 pages; Reinforced Concrete Construction, 86 pages; Railroad Construction, 95 pages; Cableways, 30 pages; Rack Railway Construction, 12 pages; Hydraulics, 85 pages; Gas Works, 48 pages; Factory Construction, 44 pages.

TASCHENBUCH FUR SCHIFFSINGENIEURE UND SEEMACHINISTEN. By Ludwig U. Linder. 411 4x7-inch pages; 394 illustrations in the text; indexed. R. Oldenbourg, Munich and Berlin. Price 5.5 marks.

This handbook for marine engineers is divided into 13 parts. Part I, Mathematical Tables, occupies 29 pages; part II, Mathematics, 38 pages, treating of areas of surfaces, volumes of solids, applied mechanics, physics and kinematics; part III, Prime-movers, 100 pages; part IV, Boilers, 46 pages; part V, pumps and Auxiliaries, 31 pages; part VI, Pipe-fittings and Piping, 24 pages; part VII, Ship-yard Machinery, 25 pages; part VIII, Electrical Engineering, 39 pages; part IX, Instruments and Measuring Devices, 13 pages; part X, Shipbuilding, 10 pages; part XI, Navigation, 25 pages; part XII, Rules and Regulations, 10 pages, these refer to the building and inspection of boilers; part XIII, Useful Tables, 30 pages.

Personals*

Charles Himmelspach, foreman of the lathe department of the Philadelphia Gear Works, has been appointed superintendent of their shop.

James H. Herron, until recently engineer in the service of the Detroit Steel Products Company, has become manager of the Motch & Merryweather Machinery Company, Pittsburg, Pa.

H. J. Weber has recently associated himself with the John B. Morris Foundry Company, Cincinnati, O. He was formerly president of the Weber Foundry Company, which was absorbed by Wessling Brothers.

Baron von Bodenhausen, chief director of the Krupp Gun Works, arrived in this city May 25, via the North German Lloyd line, "Kaiser Wilhelm II." His trip here is to be devoted to pleasure, travel, and is to be of about four months' duration.

At the annual meeting of the Machinery Club, of this city, held at its club room, May 25, the following gentlemen were elected members of the board of governors: To serve three years: W. L. Candee and E. H. Benners. To serve four years: F. H. Stillman, E. D. Meier, Charles A. Schieren, Jr., Robert C. McKinney and L. P. Feustman.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

New Machinist's Tools

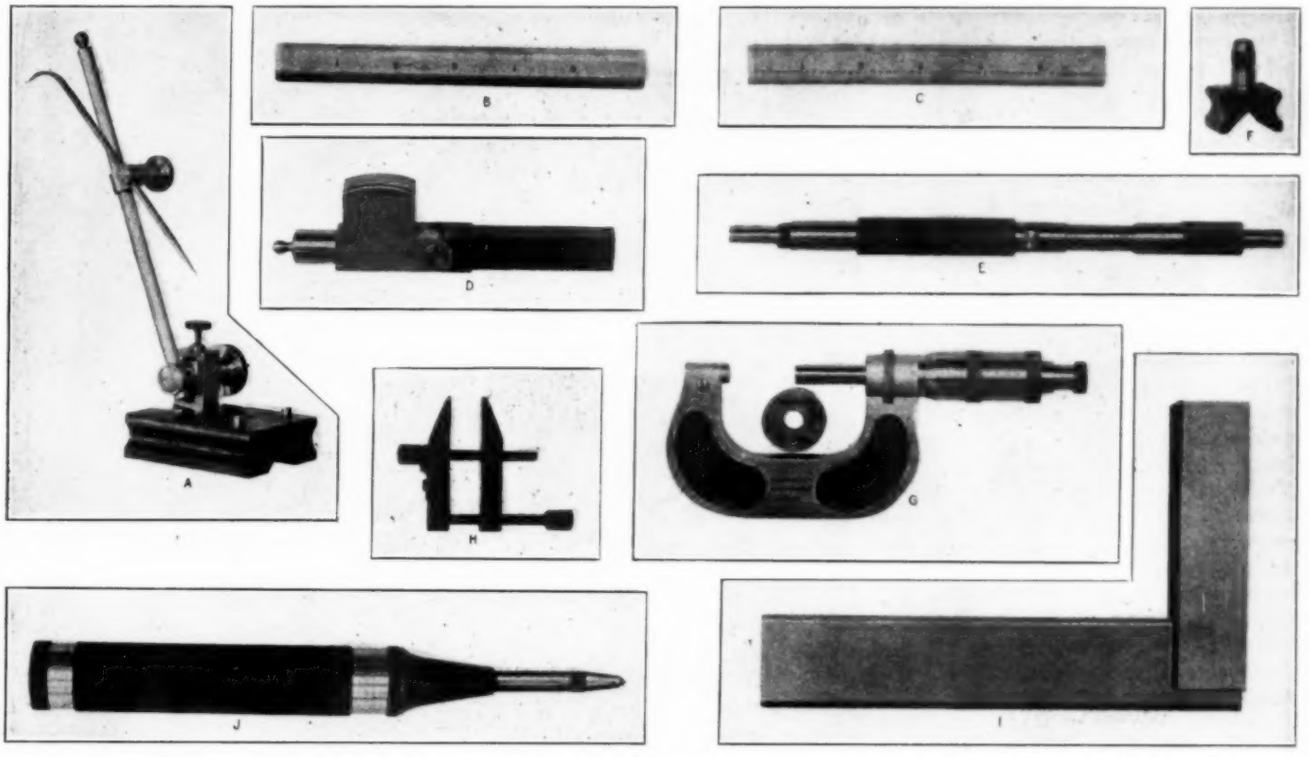
The accompanying halftone illustrates a number of machinist's tools brought out recently by the Brown & Sharpe Manufacturing Company, Providence, R. I.

Universal Surface Gage

The universal surface gage shown at *A* has a fine adjustment for the spindle after it has been set and the scriber clamped at the approximate hight. This adjustment is obtained by means of a nurled screw on the top of the spindle clamp, which, when turned, brings the spindle and scriber to the exact hight. In this device the movement is always vertical so that the tool is very convenient where exact results are required. The base is of steel, case-hardened, and of a convenient form to handle. A V-shaped groove in the bottom especially adapts it for cylindrical work. It has two gage pins in the rear end that can be pushed down and used against the edge of a plate or the side of a T-slot. The spindle swivels, can be securely clamped in any position from the vertical to the horizontal, and the scriber may be used below the base as a depth gage. For small work the spindle may be removed and the scriber inserted in a hole provided for it where it is readily adjusted. The gage is made with 9- and 12-inch spindles.

Tempered Steel Rules with Beveled Edges

The rule seen at *B* should be of advantage to the tool maker and draftsman when laying out fine work where close measurements are required. These rules are beveled on both edges of one side only, and are graduated on the beveled edges in 64ths and 100ths, and in 32ds and 64ths. They are made in lengths from 1 inch to 24 inches.



NEW MACHINISTS' TOOLS

Tempered Steel Rules with Figured Graduations

The tempered steel rules with figured graduations like *C* are convenient inasmuch as the 64th graduations are numbered on every eighth line, as 8, 16, 24, 32, etc., so that they are quickly read. The rules are graduated on the remaining edges to 8ths, 16ths and 32ds of an inch. They range in length up to 24 inches.

Test Indicator

The test indicator at *D* is distinctively new in design. The method of obtaining readings is of special importance. The point which bears against the work is of steel, hardened and ground spherical, so that pressure may be brought upon it by the work from any direction and readings obtained. A scale on the top of the case registers the movement by means of a pointer. The scale is graduated to thousandths of an inch and reads to 0.007 inch either side of zero. The shank is made of steel, case-hardened, and can be readily inserted in the tool post of a lathe. By means of a swivel joint at one end of the shank, the head may be adjusted either above or below center within a range of about 30 degrees.

Tubular Inside Micrometer Gages

One of these gages is shown at *E*. They are made of tubing, which renders them light and convenient to handle, especially those of the longer lengths. They are intended for taking inside measurements, as in measuring rings and cylinders, setting calipers, comparing gages, and work of a similar nature. Each gage has a movement of 1 inch, and the entire line embraces 32 different sizes, covering a range of from 8 to 40 inches. The gage consists of a tube or holder, provided at one end with a 1-inch micrometer head

and at the other with a fixed measuring point. The measuring points are hardened and ground on a radius, thus adapting the gage for measuring parallel or curved surfaces. Provision is made for adjustment to compensate for wear. A clamp screw is provided which securely clamps the spindle and preserves the setting. Each gage is fitted with a fiber handle which protects it from the varying temperature of the hand.

Hight-gage Attachment

At *F* is shown a handy attachment which is designed for use in connection with the inside micrometer gage, and which is useful when it is desired to obtain hights of projections on plane surfaces, the location of bushings in jigs, and work of a similar character. With it measurements can be accurately obtained ranging from 2 to 9½ inches, or 50 to 230 millimeters. The measuring rod is inserted upward through the base, and clamped securely by turning the nurled nut shown. The micrometer is then adjusted and clamped to the upper end of the rod. The base is case-hardened and nicely mottled. A V-shaped groove in the bottom adapts it for cylindrical work.

Heavy Micrometer Calipers

These micrometer calipers of heavy design are made for workmen desiring an accurate instrument for constant and severe usage. In the grinding room, for example, where the micrometer is subjected to unfavorable conditions, due to water, grit, and the necessity of taking measurements frequently with the clamp ring set, this micrometer is particularly applicable. The frame, as shown at *G*, is made of heavy I-section, and of a special design to give strength and rigidity. The spindle and threaded portion are of larger diameter than usual, which permits of greater stiffness and insures longer life to the screw under adverse conditions because of larger bearing surface for the threads. The screw is encased and protected from dirt, grit and injury. The clamp ring shown securely clamps the spindle in any desired position. Provision is made for adjustment to compensate for wear. As the thimble of the caliper is of unusually large diameter, the thousandths graduations are more distinct and easily read. Each caliper is provided with a specially designed ratchet stop. Three sizes are made, the ranges being from 0 to 1 inch, 1 to 2 inches, and 2 to 3 inches.

Improved Toolmakers' Clamp

This clamp, as represented at *H*, is provided with a spring attachment which is fastened to the sliding jaw, as shown, to prevent its dropping while inserting or removing work. It is very convenient where a large quantity of pieces of the same size are to be clamped for drilling, as it holds the jaws at the required distance for removing and inserting each piece. The clamps are of steel, case-hardened, and are well proportioned to insure strength. The jaws are round on the ends to allow clamping under a shoulder, or in a recess. The screws are of comparatively fine pitch to give ample leverage. The jaws of the various sizes of clamps range in length from 1½ to 4 inches, the smallest size opening ¾ inch and the largest 2½ inches.

Hardened Square with Beveled Edges

A hardened square with beveled edges designed primarily for use in the tool room and on all classes of work where the requirements are exacting is shown at *I*. The blade is beveled on both edges of each side, which furnishes practically a line contact with the work under observation, thus making possible the detection of slight errors. A recess in the beam, at the base of the inside edge of the blade, is a desirable feature, as it enables the user to remove dust and dirt easily from the corner of the square and so obtain exact results. The beam and edges of the blade are hardened and accurately ground for parallelism. The squares are made with 1½-, 3-, 4½- and 6-inch blades.

Heavy Automatic Center Punch

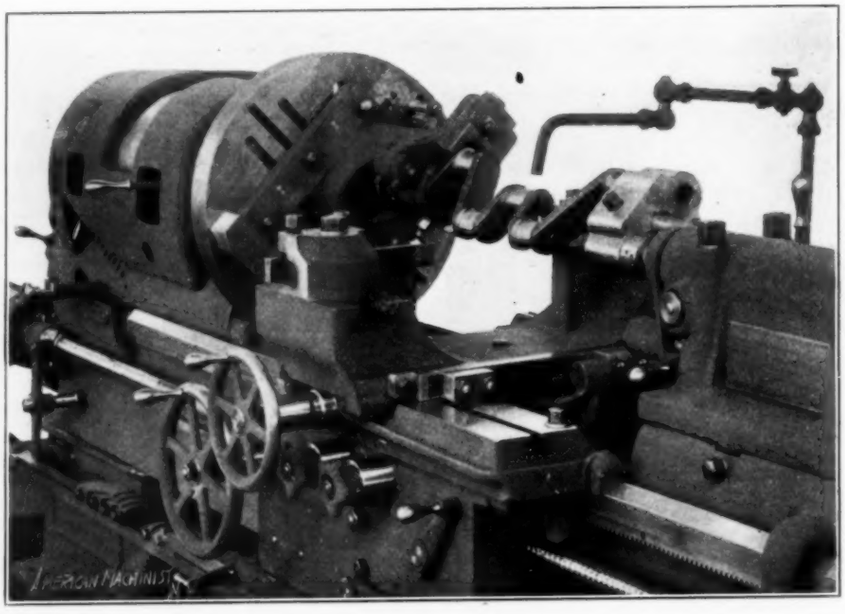
The center punch *J* is of heavy construction, and is designed for use in rolling mills for testing the hardness of metal, or it may be used in hardening rooms for testing the variation in depth in case-hardening. It is also suitable for laying out work to be drilled, where the lighter punches would not strike a sufficiently heavy blow. It is 1⅜ inches in diameter by 11¾ inches long.

A Crank Shaft Turning Lathe

The halftone shows a 22-inch by 12-foot lathe of the regular quick-change gear type built by the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio, to which has been added an attachment for turning crank shafts.

Mounted on the face plate is a sliding chuck which is adjustable for all required center distances and which is positively held in position by a locating pin. The crank to be turned is gripped in a bearing having a hinged cap and is driven by a jaw against the cheek of the crank.

The tailstock chuck is carried on a plug arbor fitting the bore of the tail spindle. A taper bearing is provided on this plug arbor for the chuck to turn on. Thrust collars prevent any possible binding on the taper bearing.



A CRANK-SHAFT TURNING LATHE

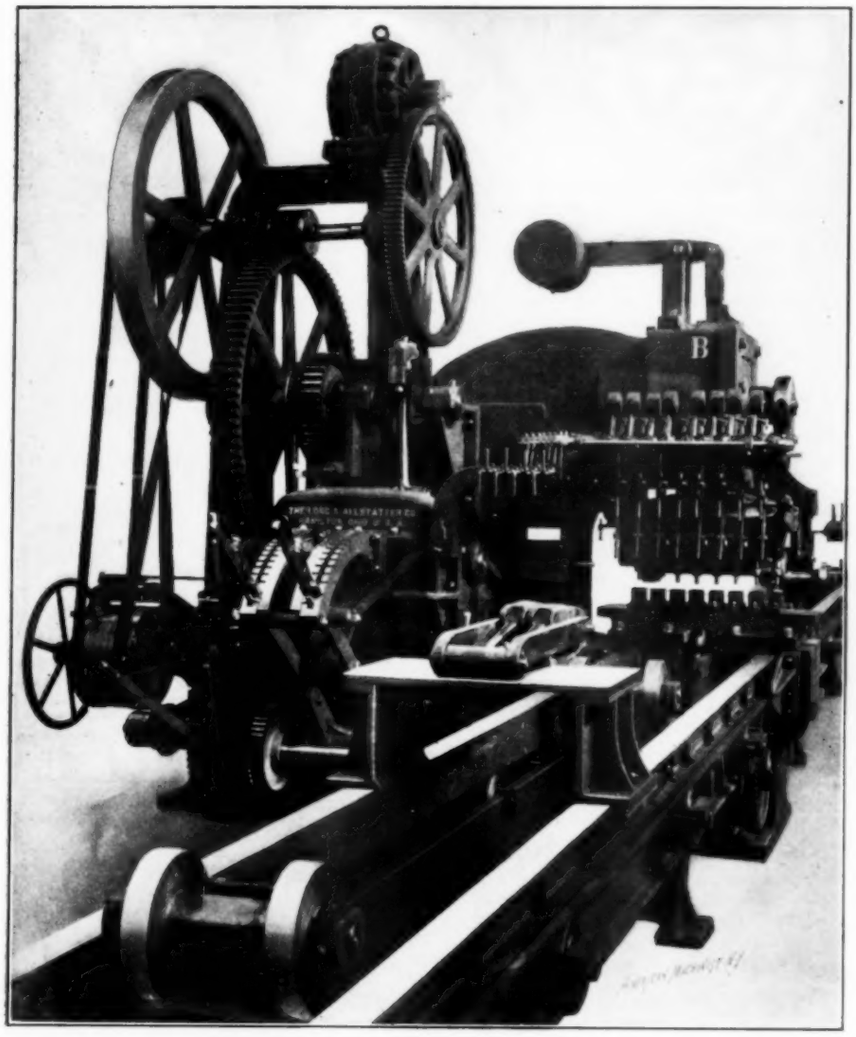
The chuck itself is a block of steel bored for three bearings. The two end bearings are taper and brushed with bronze, and may be used selectively for either the locating pin, or revolving upon the plug. The central bearing carries the crank shaft which is to be turned, being held in the chuck by means of a clamping plug.

Bolted to the front face of the tailstock is a bracket that is centered accurately by means of a hub encircling the tailstock spindle. A locating pin carried in a long bearing of this bracket serves to aline the crank in the tailstock chuck with the face-plate drive. A convenient method is provided for withdrawing this locating pin after having set the crank shaft, leaving the chuck free to revolve upon the plug arbor. The arbor and centering pin are made of tool steel and are hardened and ground.

The front and rear tool blocks are cast

as one piece with the long slide that is mounted upon the bridge of the carriage. This slide has power and hand movement.

The tools are supported by a strut cast on the saddle—a turning tool in front and two tools at the back which neck the ends of the bearing. These are first used to locate the ends of the cut and show just where to turn, although the carriage is controlled by stops on the stop bar in front of the bed. A special four-place stop is used and the latch dropped in before necking down at the ends of the bearing. This is then lifted out and the carriage run back to the tail end of the cut, the tool run into a stop and the feed thrown in. The latch drops into the notch, throws the feed-rod clutch out of engagement and stops the tool. This is same way. For changing the shaft to reach the other bearings the tailstock is run back, the driving block on the face plate shifted in the slotted fixture and the carrying block at the tailstock also changed. These are both located by positive stop pins, one on the headstock the other on the tailstock. These are first locked in position and then the crankshaft put in place and clamped at both head and tail ends, as it is very important they should be held rigidly under the cuts taken.



A MULTIPLE PUNCH WITH SOME NOVEL FEATURES

set to leave the cut about 1/64 inch short so that the exact length can be determined by moving the carriage by hand so as to force the stop bar against a solid seat on the head bracket. The rod is normally held out of contact with this stop by a stiff spring.

The carriage is then moved to the next stop and the next bearing turned in the

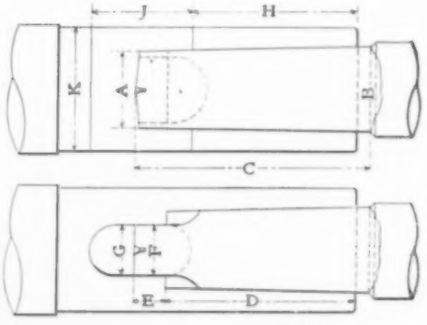
A Novel Gang Punch

This is a special gang punch, recently designed and built by the Long & Allstatter Company, Hamilton, Ohio, for use in the steel freight-car shops at Pullman. There are eight 13/16-inch punches, as shown, and these are controlled by the levers at the left of the punches so as to put any or all of them in operation at once. With these two indexing levers the operator can set the machine so that any of the punches desired will operate and the opening in the indicating box shows just what punches will act at the next revolution of the press. This feature can be set to punch in any desired sequence, making it especially valuable in many classes of work.

The spacing table will carry material 75 feet long and spaces in multiples of 1/16 inch up to 8 inches, controlled by the two large levers at the left. The thrust of the punch is 30 inches, it weighs 94,000 pounds and is driven by a 25-horsepower motor.

A New Standard Taper Shank

Taper shank twist drills with broken or badly distorted tangs have always been a source of trouble and expense. The cost of turning a new shank on them is considerable, and where this was not possible, they have been consigned to the scrap heap.



Number of Taper	Diameter Small End of Shank	Diameter Large End of Shank	Total Length of Shank	Length of Taper Depth of Hole in Socket	Length of Taper to End of Socket Hole	Thickness of Tang
	A	B	C	D	E	F
1	.378	.484	2⅜	1¾	¼	⅛
2	.587	.706	2⅞	1 11/16	5/16	⅛
3	.800	.941	2 13/16	2¼	⅜	⅜
4	1.050	1.244	3¼	3	7/16	½
5	1.515	1.757	4⅝	3⅝	½	1
6	2.109	2.501	6⅛	5	¾	1¼
7	2.815	3.283	9	7¼	1	1⅝

Number of Taper	Width of Keyway	End of Socket to Keyway	Length of Keyway	Diameter of Socket	Taper per Foot	Taper per Inch
	G	H	J	K		
1	.263	1⅝	⅝	25/32	.600	.0500
2	.388	1¾	1	1 5/16	.602	.05016
3	.520	2	1¼	1 15/16	.602	.05016
4	.645	2 11/16	1⅝	1 11/16	.623	.05191
5	1.020	3¼	2	2 5/16	.630	.0525
6	1.270	4⅝	2⅝	2⅞	.626	.05210
7	1.520	7	3		.625	.05208

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A NEW STANDARD TAPER SHANK

The Standard Tool Company, of Cleveland, Ohio, is putting on the market drills, sockets and sleeves, having short taper shank. This overcomes the trouble by means of a tang of much greater strength.

Sockets and sleeves are furnished, made with the outside taper to fit the old taper of spindles of drill presses; the inner taper being suitable for the new shanks and also made with both outside and inside taper, conforming to the new standard, and these latter interchange or nest into each other.

The tables give the exact dimensions of all sizes of these new taper shanks, known by the trade name, "Stantool."

The same concern is also manufacturing a gage, which placed over the regular taper shank, shows the size and location of the tang for the new shank. This enables drills on hand to be converted into the new type, and also enables old drills from which the original tang has been broken, to be utilized.

Automatic Turning Lathe

Our readers are familiar with the automatic lathe built by the Fay Machine Tool Company, Philadelphia, Penn., this machine having been already fully illustrated in these columns. The accompanying halftone brings out clearly the principal features of a new size of machine built by this concern, which swings 24 inches over the ways, 18 inches over the carriage and will take 36 inches between centers, the carriage having an automatic feed of 14 inches. The work handled in this lathe is mounted on an arbor between centers and the machine is especially designed for turning pulleys, spur, bevel and worm gears, hand wheels and cone pulleys, facing and threading pipe flanges, etc. This lathe, as well as the 14- and 18-inch sizes, which are of the same general design as the one illustrated, are made so that chucking can be done on them if desired.

The Edgemont Clutch

This clutch has been designed for use on counter- and lineshafts to take care of the demands of the present day in the use of high-speed steel. The fact that it is being used on the countershafts of several toolbuilders is an evidence that it does the work.

Fig. 1 shows the clutch applied to a large pulley although its usual application is on the inside of the pulley rim. The friction ring is shown in Fig. 2, the method of splitting being a little peculiar. In addition to being cut across the rim at one side of the arm, the ring is also split the other way for perhaps a quarter of the circumference. This adds to the flexibility of the friction ring and aids in its taking hold easily, yet does not detract from its final holding power when fully expanded.

FIG. 1. THE EDGEMONT CLUTCH

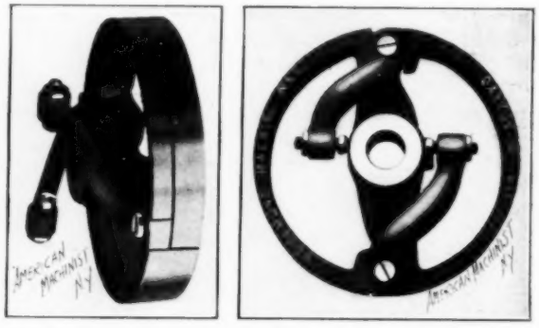
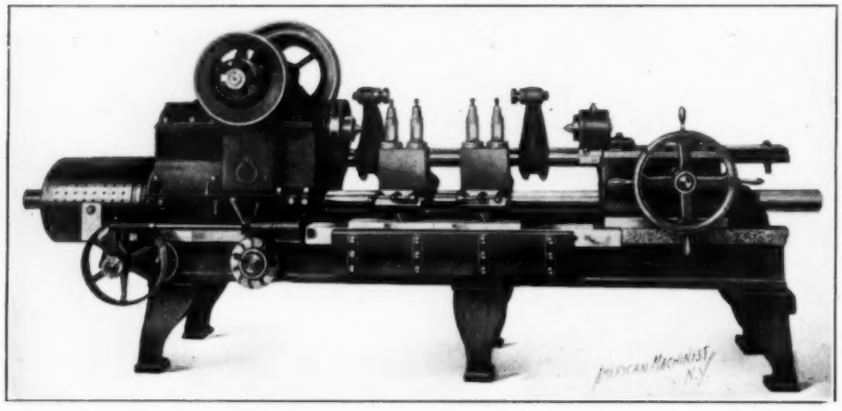


FIG. 2. TWO VIEWS OF THE EXPANDING RING



AUTOMATIC TURNING LATHE

Either the complete clutch or the friction rings are furnished as desired. The makers are the Edgemont Machine Company, Dayton, Ohio.

Combination Milling and Boring Machine

The requirements of a special class of work led to the design of the machine shown herewith, which can be used for either milling or boring, particularly in shops which do not have enough of either kind of work to keep a separate machine busy.

It needs very little description, con-

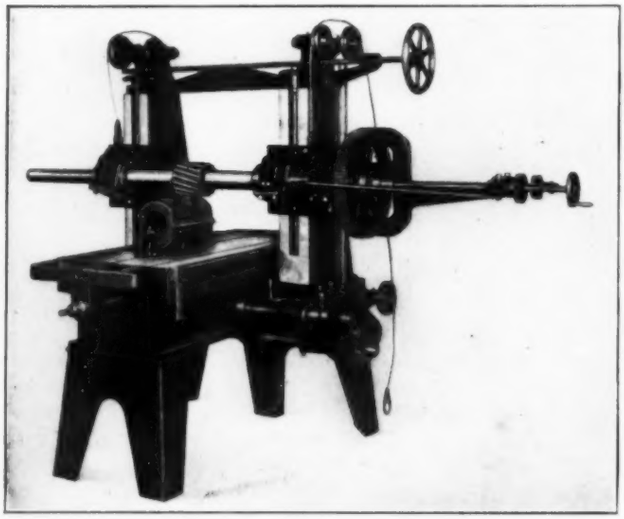


FIG. 1. USED AS A MILLING MACHINE

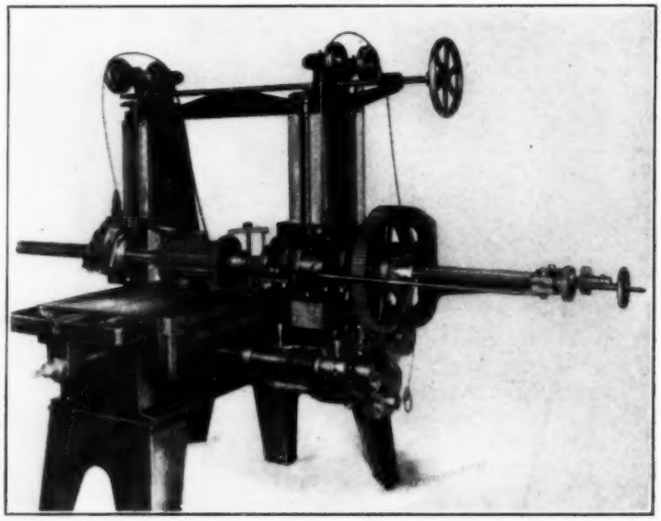
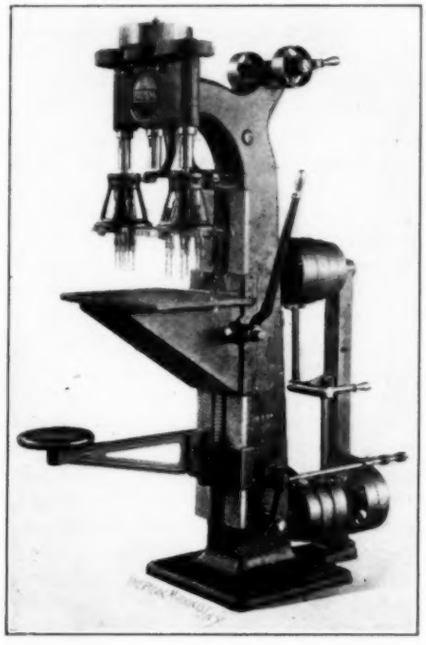


FIG. 2. AS A BORING MACHINE

sisting of a planer type milling machine with a boring attachment connected to one head. The heads are counterweighted, the ropes shown slack, being connected to weights in tubes extending down below the floor. The table has a feed of 4 feet, the boring head has a feed of 24 inches, and will take 24 inches between the housings with the same distance under the rail. The machine has the usual feeds and knockouts and weighs 6000 pounds. It is built by the Cincinnati Punch and Shear Company, Cincinnati, Ohio.

A Three Spindle Sensitive Drill Press with Multiple Spindle Attachments

The machine shown in the halftone has been brought out by the Baush Machine Tool Company, Springfield, Mass.,



A THREE-SPINDLE SENSITIVE DRILL PRESS WITH MULTIPLE-SPINDLE ATTACHMENT

to supply the demand for a multi-spindle machine smaller than their regular line.

The three-spindle machine shown, while designed to accommodate small multi-spindle head can be used as a three-spindle sensitive drill press. This line of tools is built with four or less spindles. Maximum capacity with one drill 1 inch; distance center to center of spindles 7 inches; maximum distance table to spindles 26 inches; travel of table 22 inches.

Beneath the table is a swinging revolving seat for the operator which is adjustable for hight on the column of the machine.

The six-spindle detachable multi-spindle heads shown usually have a maximum drill circle of from 5 to 8 inches but special heads will be furnished on order.

A Pipe and Nipple Threading Machine with an Automatic Opening Die Head

The body *A* of the die head is of cast iron, bored and turned true, and a standard size so as to be interchangeable. Across the face of this body are milled T-slots for carrying the steel die blocks. The outside flange of this part of the head is machined at the back internally as a guide for the adjusting shell, and also serves to exclude cuttings from the working parts of the die head.

The hub is bored and keyseated for the steel driving shaft, and the outside is fitted for the sliding collar *B* to work upon.

The sliding collar *B* is fitted part of its length internally to slide upon the hub of the body, the remaining portion threaded to receive the collar *C* for adjusting the length of thread to be cut when the machine is in operation. The exterior of the sliding collar has four lugs, milled and drilled to receive the fulcrum end of the bearing levers, also the thread upon which the adjusting shell *D* is carried and the recess to receive the shoe attached to the yoke for closing the die head.

The adjusting shell *D*, carried upon the sliding collar at the back and guided within the flange on the die body at the front, is the means of positive universal adjustment of the dies through the double wedge action on the bearing levers, shown in the sectional cut Fig. 1.

All parts described are machined outside and inside to obtain perfect balance of the assembled head.

The die blocks *F* are of machine steel, case-hardened, carefully fitted to the slots in the die body to exclude cuttings and give extra long and durable wearing surfaces.

The tempered steel bearing pin *E* forms the back of the die slot, takes the thrust of the chaser *G* and is also the bearing upon which the tool-steel bearing lever works. This bearing pin is a fit in the die block, has a solid backing and can be removed readily when necessary.

The bearing levers *H* are of tool steel tempered at the point of the bearing on the bearing pin, and turned to give ample bearing on the adjusting shell.

The dies *G* are of tool steel, with straight back held in position each with one pointed set screw, entering in the die,

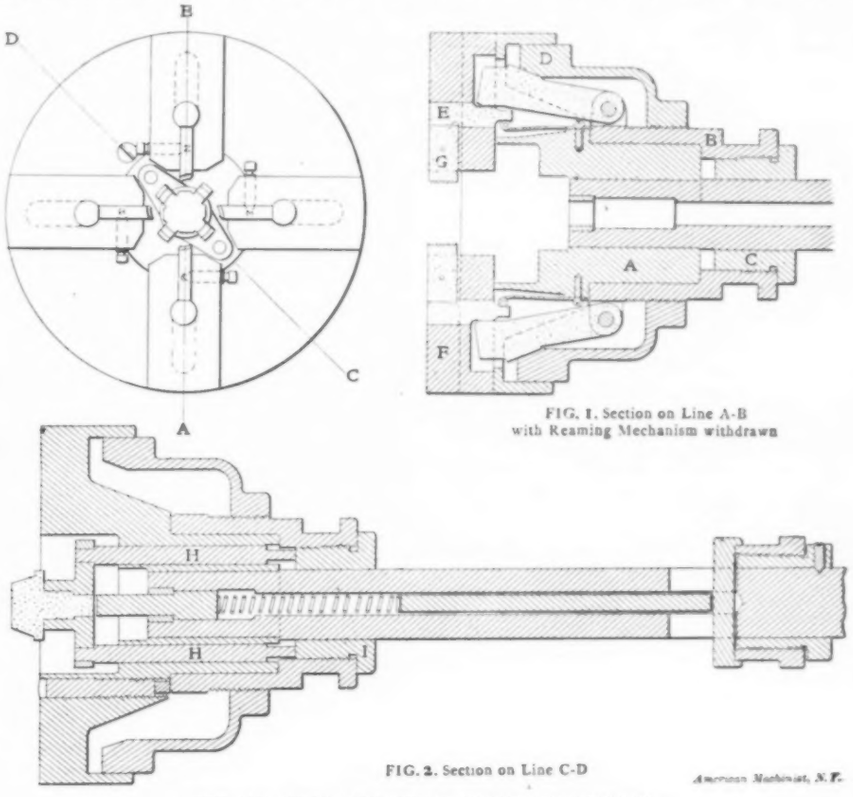


FIG. 1. Section on Line A-B with Reaming Mechanism withdrawn

FIG. 2. Section on Line C-D

American Machinist, N.Y.

THE DIE HEAD AND THE REAMING ATTACHMENT

making it quick and easy to change sets when desired. The dies may be recut from three to four times to original size before discarding.

The adjustment for light or heavy internal reaming is independent, varied as desired and shown in sectional cut No. 2. Owing to the construction extra reaming tension that may be applied will affect the reaming only when the thread is well through the dies where the heavy reaming will not cause a thin thread.

The reamer holder shown in Fig 2 is malleable iron, part of its depth being squared to receive the square on the reamer shanks. The reamers are held in place by a single pointed set screw.

The reamer rods *H*, attached to the

reamer holder, pass through guide holes in the body of the die head and, coming in contact with the adjustable collar *I* in the back of the sliding collar, push the bearing levers off the bearing pins, allowing the die blocks to be thrown open by the positive spring action when the thread length has been attained. To prevent accident, the reamer rods are shouldered to strike the sliding collar should the adjustable collar be too far out (see Fig. 20).

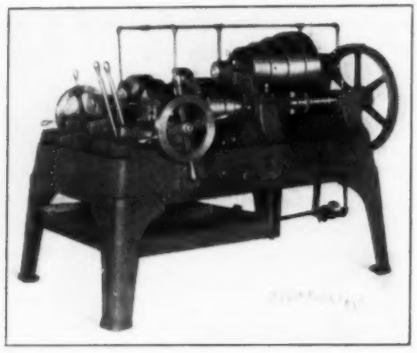


FIG. 3. DOUBLE-HEAD PIPE AND NIPPLE THREADING MACHINE

When the die head is open, the reamer holder, with rods, may be drawn out, permitting long or running threads to be cut.

Fig. 3 shows the double-head pipe- and nipple-threading machine, to which the automatic die head described is applied. It is built by the Murchey Machine and Tool Company, Detroit, Mich.

Trade Opportunities in Brazil

By M. de Moreira

The lesson which the panic of 1907 should have taught manufacturers in this country seems to have been forgotten. At that time when business at home was scarcely to be had, manufacturers were more than willing to do their utmost to obtain trade in foreign countries and especially in South America.

"Passed the feast, forgotten the saint," say the French people; we could very well say: "Passed the crisis, forgotten the lesson." The exports we were so anxious to obtain then, the exports we then sought, going so far as to send advertisements and circulars broadcast to foreign countries, those very exports do not interest us any more. We no longer busy ourselves with the opportunities which those countries offer us, and we make ourselves believe that, as we have not secured in two or three months a good slice of the foreign trade, the European competition is too much and very few opportunities exist there for us.

The first reason is too weak to be very serious, as an American manufacturer of good machinery or machine tools should welcome competition where his goods will prove their superiority over inferior European makes, even if their cost is higher, as an increase in price is generally the result of larger output or labor-saving features. An increase of speed in one machine over what another machine can do, is not to be taken as a basis from which the foreigner will figure the actual cash value of the faster machine, but one where he will realize that it is a five- or a ten-per cent. increase of earning power, and the same reasoning will he follow for labor-saving devices.

The second reason has still less force as opportunities for trade in machinery and machine tools in South America are increasing daily.

Increased Railway Mileage

Let us take Brazil, since this republic is the largest, the most populous and the most progressive of all the South American republics. Since last year 435 miles have been added to the railway mileage of Brazil, making a total of 10,000 miles.

Not satisfied with that, the government is to build a railway connecting the terminal of its line in the state of São Paulo to the Bolivian frontier; another contract has been signed by the state of Minas Geraes for the extension of the Leopoldina railway system from the present northern terminal at Santa Luzia to connect with the Leopoldina branch coming up farther west. The extension will be over 200 miles long and, still another arrangement has been made with the Great Western railway, of Brazil, for the construction of a line in the state of Parahyba do Norte.

There is, therefore, a great demand for machinery and machine tools for these new roads, as well as for the old ones, as in the latter the construction of rolling stock is increasing daily and the government favors most strongly the local manufacture thereof.

Another interesting feature is that the railways now in operation in Brazil are 47 in number, of which 23 are owned by the government and 24 are controlled by private corporations, making it easier, therefore, for machine-tool manufacturers to obtain orders, than if the roads were controlled by only two or three corporations.

Electric Railways

Electric tramway service has increased in a still larger proportion. Every city of any size has now electric roads, either complete or under construction, and in most of the large cities they build their own cars. The most important electric road under construction at present is to connect Rio de Janeiro and Petropolis.

This line is a notable undertaking. It is to pass around a portion of the great bay of Rio de Janeiro, then across a large portion of the bay by way of islands and a series of bridges at the foot of the mountain range and then ascend the mountain, a distance of nearly 2800 feet. To reach the opposite side of the bay, the line will pass across three bridges; one 785 feet, a second 1115 feet and the last one 2.2 miles long. The whole length of this line is to be 37 miles. It will cost $1,800,000 and, according to the requirement of the government concession it must be finished within four years.

Dock Construction

The building of docks should also interest our manufacturers. So far two miles of docks are under construction, but plans have been made and approved for the additional building of ten miles more of dockage, which will cost the government over $20,000,000. Thus when the work is completed Rio de Janeiro will have the greatest dock system in South America.

To secure additional frontage, piers will be built at right angles to the shore to the north of the present docks, which are constructed as a curved frontage of the bay without slips or piers. What an amount of machinery and machine tools will be needed and what an opportunity for American manufacturers is here opened up!

The Brazilian government has decided, moreover, to build a new dry dock on the Isla das Cobras for the accommodation of the Dreadnoughts. This dock will be available for merchant vessels as well as war ships, and is a most important step in the maritime development of South America. The dock is to be the result of a reconstruction of the old dock, owned by the government. This dock is to be widened and deepened much along its present lines. By the plan finally adopted, 100,000 cubic meters of rock will be excavated from the bottom, sides and land end until the dock will have a total inside length great enough to admit a vessel 250 meters, or about 815 feet long. It is to be divided into three sections of 150, 70 and 30 meters, respectively, so that three vessels of proper size can be handled at the same time. The dock is to be fitted with the latest appliances for naval and merchant vessels' need and will afford conveniences for the docking and repair of vessels of 16,000 tons.

It is not only in Rio de Janeiro that these opportunities exist. The ports of Para, Natal and Pernambuco are being improved and docks are being built at Bahia and Victoria. Shipbuilding in Rio and Para is also increasing and repair shops are being established or increased in size all along the eastern coast.

The Textile Mill Industry

The largest industry in South America, and especially in Brazil, is, without doubt, the cotton industry, and cotton mills have so increased that a continuous decline of imports has resulted. As a matter of

fact, 36 per cent. of all the capital invested in Brazilian industrial establishments is used in the operation of cotton mills, the machinery of which, it is regrettable to say, is mostly of English make.

One of the fields offering great inducements is that of textile machinery, which has heretofore been furnished almost entirely by British manufacturers. At the present time, however, British factories pay less attention to the South American fields, and American manufacturers of textile machinery and gin manufacturers have now the best opportunity.

The greater part of Brazil's textile industries are confined to cotton mills, although the woolen industry is receiving considerable attention, especially in the southern part of the republic, and some very fine woolen products are being turned out by factories in the state of Rio Grande do Sul. German and English machinery is most in use now, but the Brazilians would welcome a chance to get some American-made machinery.

Woodworking Machinery

Another line of machinery which deserves attention is that of the sawmill appliances and woodworking machinery. The Brazil Railway Company is fast opening up the best timber lands in the republic and is giving a strong impulse to the lumber business in the southern states of Brazil.

Other Industrial Developments

The increase of rice culture has also created a new demand for rice machinery which, as well as the establishment of numerous factories for the refining of sugar, will permit American manufacturers of suitable machinery to enlarge their trade and supply many factories with entire outfits. Upon such machinery for use in factories, the government usually remits the duties. It seems opportune to give here a list of other important native industries which require machinery of every kind, such as: chocolate products, paper mills, hat factories, ironworking, fences, tanneries, furniture, etc.

The Brazilian people thoroughly understand that the United States provides a greater market for their products than any other country and are perfectly willing to reciprocate and give the United States the greater part of their trade if the manufacturers will take the trouble to go after it earnestly.

Changes in Customs Duties on Machine Tools Imported into Australia

By A. J. Wolfe

The agent of the Commonwealth of Australia in London has received from his government an amended list of machine tools which were formerly on the free list, but which have now been reclassified and are made dutiable under various items of the new customs tariff.

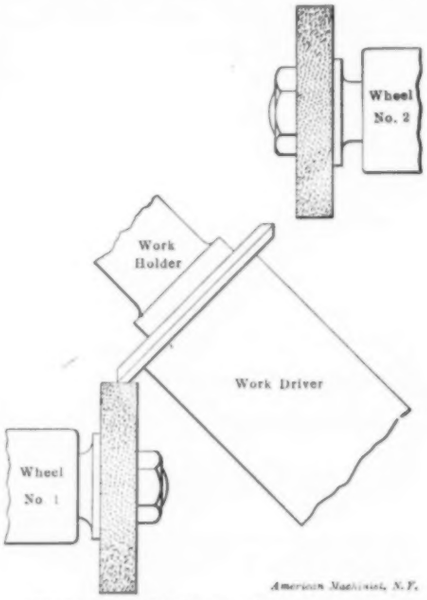
For purposes of convenience the customs tariff section, including machine tools are quoted in full, with the new additions to the dutiable list in italics:

		Of Non-British Origin.	The Product of the United Kingdom.
162–C	Machines and machinery not elsewhere included	25% ad valorem	20% ad valorem
	This section now includes the following machine tools, *until now on the free list:*		
	For metal working—		
	Arbor or mandrel presses, bending elbows for gutter and stove piping, bobs or wheels (leather), polishing for lathes, boring and drilling (horizontal), calking and chipping machines, chuck set with drills, copying lathes (for metals), cornering and punching, cropping, cutter-making, chucks for lathes (excepting drill, independent jaw, scroll and special chucks, free), cutting (tooth wheel or gear), drilling (radial), finning, flanging, forging, groover or dado head, guards (saw bench), keyseating, lathes, under 12 in. center, milling (other than Universal), nail-making, nut-making, nut finishing, planing, plates (lathe face), profiling, punching bars, punching and cornering, riveting, rivet-making, cold iron (for cutting cold iron), saw bench, shaping (12 in. and under in stroke), drill sharpeners, straightening, threading and boring tools, washer making, hydraulic wheel presses and screwing machines (other than bolt screwing and nut tapping)	25% ad valorem	20% ad valorem
	Bolt screwing and nut tapping (combined or separate)—		
	Adapted to accommodate sizes to cut over 2 inches only	25% ad valorem	20% ad valorem
	For paper finishing, cutting and folding—		
	Bending and creasing, cutting (label, lever, millboard), damping, knives for paper cutting machines, also power stripping machines, similar to card cutting machines	25% ad valorem	20% ad valorem
	For wood working—		
	Boring, carving, copying lathes, double spindle shaper, dovetailing, fretwork, heing sawing, hub borers, joining, lathes, mortising, molding, panel planer thicknessing, patent door sticking machine, planing, rounding, saw frame double equilibrium (a machine tool for re-sawing and cross-cutting, also for sawing two deals at once), sand papering, saw brazing saw sharpening, spoke-making, surfacing, tenoning, tongueing and grooving, trying up, wheel-making lathes, also veneer-cutting	25% ad valorem	20% ad valorem
165–B	Machine tools, metal working—		
	Wire netting machines, pneumatic hammers, other than hand pneumatic hammers, steam hammers, up to and including sizes up to 16 in. cylinder; punching and shearing machines, combined or separate, sizes up to ¾ in.; slotting machines, sizes up to 12" stroke; centering machines to center up to 6 in. diameter, bolt screwing and nut tapping, combined or separate, sizes above ¾ in. and up to 2 in. *Also adapted to accommodate sizes to cut over 2 inches,* bending rolls in sizes to bend up to ¾ in. plate	15% ad valorem of whatever origin	
	Tinsmiths tools	15% ad valorem	15% ad valorem
16–C	Machine tools as prescribed by the Customs Department	free	free
	(Those mentioned in the appended table in italics have just been removed from the free list.)		

A Neat Grinding Rig

A neat grinding fixture was recently devised by the Dayton Machine and Tool Company, Dayton, Ohio, to grind the beveled edges of small friction-driving wheels for toy locomotives. These wheels are of cast iron, about 2 inches in diameter, and have a 45-degree bevel on each side which works in a frictional arrangement so that they must be true and of correct size.

The sketch shows how this was done with very little trouble, the work being



DEVICE FOR GRINDING A BEVEL ON SMALL WHEELS

held and revolved at an angle of 45 degrees from the grinding wheels. It is only necessary to stop the work-driving spindle, take off the finished wheel and put on a new one, snap the back stop or holder into place and start up again. Then the head carrying the work is moved past one wheel and then the other, grinding both sides in short order and making a very good job of it. The setting of the two grinding wheels determines the diameter of the driving wheels as they are ground to a sharp corner.

Tinol: A New and Valuable Solder

Soldering or "soft soldering" is an art that is certainly as old as is the use of lead and tin. Until a very recent time the practice was to moisten the carefully cleaned joint with some acid flux, generally muriate of tin, and then flow melted

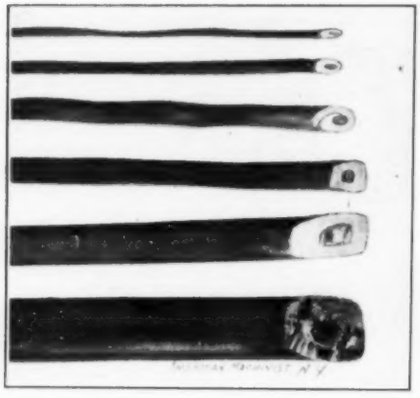


FIG. 1. RODS AND WIRE OF TINOL

solder along the joint by means of a heated and tinned soldering iron or copper. If the acid was not very carefully neutralized after the joint was completed a slight remaining excess was certain to eat into the metals joined, and this in some cases proved disastrous. To overcome this powdered rosin was substituted for the acid flux; while this cured all danger of acid eating, the difficulty of making a good joint was greater and the work was apt to be sticky, and not as neat.

As is well known to every metalworker, all alloys of lead and tin, on melting in contact with air, form oxides or dross. The presence of such oxides prevents metallic union of the solder with the metal to be joined. The so-called fluxes, as acid or muriate of tin, rosin, etc., serve to protect the melting solder against direct contact with the air and hence against such oxidation.

Tinol is a new material, originating in Germany. It consists of finely granulated solder, each grain coated with a fatty organic substance which is neither acid nor alkaline. This coating or flux begins to melt before the solder, but is not completely evaporated until the solder has set; it thus protects the solder fully against oxidation during the entire operation.

Practice has shown that with such materials as tin, lead, brass and copper, no special cleaning as by scraping or dipping is necessary; if the joints look clean to the eye that will be sufficient. Iron and steel must be cleaned of rust and scale.

This mixture of granulated solder and fatty flux forms a paste called "tinol paste." It is of a consistency that allows its easy application by a knife blade, glazier's spatula, stiff bristle brush, or even with the fingers. The paste is marketed in tin cans.

By the usual method, using ordinary solder, the three joints soldered in an underground cable sleeve that was 4½ inches diameter and 14 inches long averaged an hour, and between 6 and 8 pounds of solder was used, including the melting-pot waste. With tinol the average amount of solder used per sleeve was reduced to 2½ ounces, and the average time for each joint to 21 minutes. As regards the strength, out of a total of 20 sleeves tested at 50 pounds pressure all of the tinol joints were sound, while with ordinary solder imperfections were found in three out of every ten.

Joints in cables, on being sawed open, showed that all interstices are completely filled with solder. Resistance tests show fully as high a conductivity at the joints

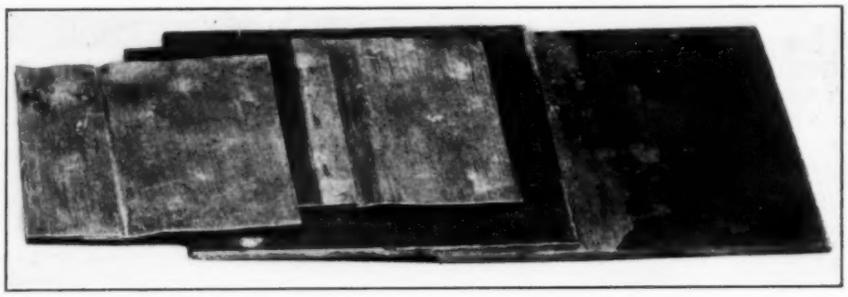


FIG. 2. STEEL SOLDERED TO STEEL WITH TINOL ALSO IRON TO LEAD AND LEAD TO LEAD

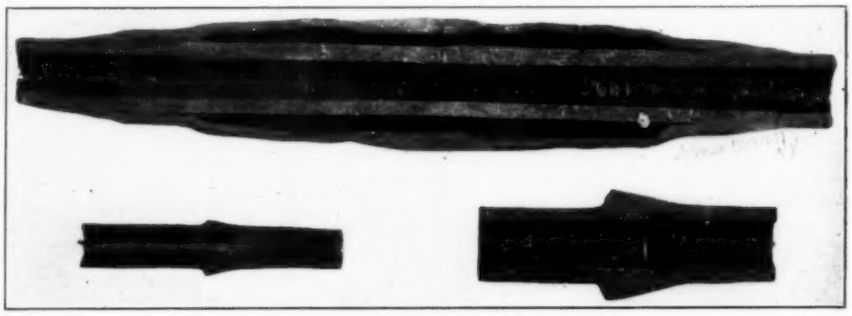


FIG. 3. LEAD PIPE JOINTS MADE WITH TINOL

As it is convenient for some work to use solder in stick and in wire form, Tinol is made up also in rods and wires of different sizes, ranging from 5/6 inch down to 1/32 inch. These rods and wires are all hollow and contain the same flux used in the tinol paste. They are shown at their full size in Fig. 1.

Any source of heat may be utilized, as a gasolene or alcohol torch, hot poker, the usual copper, etc. For light work an ordinary wax match will answer. One advantage of the fine granulation of the solder is that much less heat is needed than with bar solder, since each grain melts much more readily.

In this connection a report of a test made by the German post office (that controls the telegraphs and telephones)—Hamburg district—may prove of interest. as elsewhere. When using tinol it is feasible to prepare a number of joints for soldering and then quickly pass from joint to joint with the torch.

As tinol paste is applied to the cold joint, the awkward handling, resulting from the need of holding the wire (frequently necessary in confined places) and at the same time applying the solder and heat is avoided; a helper is, therefore, never needed and the work even in confined quarters is rendered easy.

Droppings, that with ordinary solder are practically unavoidable, are absent with tinol, since experience soon teaches just how much paste to apply in the cold state to insure the filling of the joint and no more. If by chance not quite enough has been applied, a little more may be added to the cooled joint and then melted

in. In much electrical work, droppings are dangerous unless carefully removed, as they may cause short-circuits and serious trouble.

An entirely new method of soldering has been found possible in some lines. Tinol paste was applied to the various joints and a sufficiently heavy current passed to melt this; wherever applicable this gave particularly good results due to the heat passing from the inside outward.

Brushing the paste onto broad surfaces, bringing these together under the requisite pressure and heating in gas furnaces has given very good results for quantity work. For lesser quantities pressing between heated tongs is a neat and effective method.

For narrow joints in sheet-metal work the paste is applied to the edge of the joint and then heated in any convenient way, by torch, soldering iron, etc.

For wider joints the paste is thinned down with a little water and applied with a stiff bristle brush. This is then heated with a torch, or otherwise, as may be convenient until the metal glistens; in this way the entire surface of the joint is at one operation thinly and uniformly coated with clean tin. A second application of paste is then made, and the parts laid together under pressure and heated. A perfect union of the entire surface is the result.

It is easy in this way to get perfect joints of several inches in width between thin and thick brass, copper, iron, steel, galvanized metal, nickel-plated metal, lead, etc. Nor need the metals to be joined be similar; perfect joints between any dissimilar metals of those mentioned are readily made.

The three sheet-metal forms shown in Fig. 2 are of two sheets of lead 0.018 inch thick, with a joint 7/16x3½ inches; sheet lead 0.018 inch thick soldered to 0.022-inch sheet steel with a joint ½x3½ inches; two iron plates 0.117 inch thick soldered with a joint 1¾x4¾ inches.

Absolutely tight connections for piping are made by smearing the threads with paste, screwing together, lightly heating and then screwing up solid while hot. This use in pipe work led to its application as a nut lock. A light covering of the screw threads with paste and heating with a torch while screwing home results in so intimate a union that the body of the bolt twists off before the nut comes loose; but when loosening is required, heating with a gasolene torch makes that easy.

Joints made on lead pipe with this solder are shown in Fig. 3. This material is being introduced in this country by the American Tinol Company, of Philadelphia, Penn., in the shape of tinol paste, rods and wire in varying proportions of tin and lead, ranging from 100 per cent. tin down to 20 per cent. tin and 80 per cent. lead.

Among the Shops

Editorial Correspondence

Planing and Scraping

There has been considerable discussion in the columns of the American Machinist during the past year as to proper planing and scraping, with a decided leaning toward the idea that much scraping can be avoided if we pay more attention to good planing. This seems to be a very reasonable contention and, as has been stated, is borne out by the practice of the Landis Tool Company in its grinders.

But, perhaps the fountain head of this idea or belief is the G. A. Gray shop in Cincinnati, where it has been carefully practiced for years and where remarkably fine planing is done on all their work. It would pay any firm to send their planer foreman to the Gray shop to study these methods of planing.

As an example we may cite the planer beds and tables which are planed to gages, the loose iron scraped off and the planers assembled, without scraping each table to its particular bed. I can see incredulous smiles in some quarters, and salesmen who know more about talking points than they do about the machines they are selling, sharpening their little hatchets—but the fact remains that this is exactly what they do and that the parts fit so well they do not need scraping.

The tables can be turned end for end and they run just as well. I ran across one case where the dealer had forgotten to order the special table required and the customer prepared to send back the whole machine until he was notified that it was not necessary. He was asked to return the table only and in the meantime the new one had been made and shipped. He was on the anxious seat until it arrived but to his surprise it fitted.

Nor is this kind of work confined to planing in the Gray shop. A few years ago they made a shipment to Europe and on arriving in New York for the steamer one box was missing. Time was precious and instead of holding the whole shipment, they simply took another set of parts out of stock and sent them by express.

It so happened that these were important parts, such as the main shaft, bull wheel, etc., but they went along without ever having seen the planer bed they were going into and they fitted when assembled on the other side.

After two years of wandering over the face of the earth, from Hoboken to other out-of-the-way places, as only railroad shipments can, the missing box turned up. The railroad company, anxious to save its dollars if not its reputation, wanted to know how much they could allow for the stuff (for, strange to say, the claim had been paid under two years) and were overjoyed to find it could go into stock and not to the junk pile.

All this isn't intended half as much to advertise the Gray shop as it is to show that it pays to do better planing and less scraping than some of us have thought necessary or possible, and that interchangeable work can be made at a moderate cost and has many advantages.

Talking Points

Some of the talking points used by salesmen are funny, and would be still more so if they were not so exasperating and disastrous to really good products. But after all, it's probably up to the buyer to know something about what he wants and what is good and bad in mechanical matters.

One salesman got hold of the fact that Gray didn't scrape the ways to a bearing and used it—effectively too in a few cases where the buyer didn't know any more than he did—as an argument against its workmanship. Told how long it took them to scrape a bed in, as an evidence of good work. Not that all scraping is bad—only the less that is necessary, the better for the tool and the cash drawer.

Then the automobile salesman talks about his engine or the other fellow's, most of the time.

"All our cylinders are ground vertically. No one else does that and you know (emphasis on the you to make the buyer feel good) that horizontal grinding can't be right. Dust stays in there and it can't be true to the thousandth as ours are."

Next man says: "Grind his cylinders vertically—sure he does, on an old boring mill that isn't true and never was. He is partly right though about some horizontal grinding, but with ours the cylinder is stationary and the wheel travels around the wall. No other way touches it."

Another tells you they don't grind at all. That's the cheap way to get a finish. But the wheel wear, the grit left in the cylinder and forty other things are bad—with a big B. He reams his, that's the only way to get a *good* cylinder.

And the next man finishes with a single-point tool, can't get a really true cylinder any other way. He leaves a little roughness, that is, he don't want a dead smooth wall. His holds the oil and the natural glaze from wear is the only thing.

But the last man grinds every piston into its own cylinder. No other way to get a perfect fit. That's why he won the great Rockerspilt cup—his piston fitted and the rest only thought theirs did.

These all sound good if you say them right, with the emphasis in the right place and have the winning smile that assures the customer he knew it all before. But as a matter of fact, all of them are a good deal nearer round and true before the engine is run than they are when it is turned into a rapid-fire gun. It's pretty safe to say none of them is within a row of apple trees of being round while running.

Fine Engraving

Some of the finest examples of die cutting and matrix making I have ever seen are in the shop of Werking & Hardringe, Chicago, Ill., who have made many hundreds of the matrices for the various plain and fancy types we have all seen in use. But what impressed me as about the limit of hand work was a little name stamp cut by Mr. Werking and reading "R. Werking" in plain Gothic letters when seen under a strong glass. Yet the whole length of the name—eight letters, the period and the space—lacked a trifle of being ⅛ inch long. It stamped the name so as to be read very plainly with a good glass.

Another fine job of a different character was found in the engraving-machine department of the George Gorton Machine Company, Racine, Wis., the work being in charge of Mr. Rockwell.

He handed me a small piece of sheet brass which I should have called plain had I not known it must have had some reason for being preserved. A faint impression was visible in the center and it took a very strong glass to bring it out that this was engraved with the full name of the company in letters 0.003 inch high with every letter perfect.

This, of course, was simply a "stunt" to see what could be done, but the regular engraving from copy sent in is an interesting process, involving an application of photography, or at least optics, in the making of the original pattern for the machine.

The original copy, be it a nameplate, signature, or what not, is thrown upon a sheet of paper by an enlarging lantern and the outlines are traced carefully. This is mounted on cardboard and the whole thing then mounted on sheet zinc. Then it is cut out, down to the zinc, and varnished to harden and preserve the edges of the pattern and a new metal pattern is cut, from which the final cutting is done.

The paper pattern is made very large, say 10 to 15 times the intended size. This is reduced to perhaps four times the desired size for the permanent pattern so that any error in tracing is divided or reduced until it practically disappears in the finished product. The well known pantograph motion is used to get the desired variation of size.

Gear Driven Machines

There are more opinions, pro and con, on gear-driven machines than almost any other subject just at this time. Some shops are building nothing else, some make either gear or cone driven, recommending the gear drive for the heaviest work and the cone for average or light work, while still others build nothing but cone driven tools and decry all attempts at gear drives.

Geared drives themselves vary from the old cone of gears, such as is very common in feed boxes to sliding gears—a la automobile—and to positive and friction clutches, with a great variety of combinations of each.

But the real confusion of ideas begins when we go into the shops and see what is being used. We are told by some it is impossible to do really fine work with a gear drive because the gear marks are bound to show, yet we find good work being done in some places without a trace of the marks, and they are all enthusiastic for gear drives.

The next shop makes a gear-driven machine for the other fellow when he wants it, but doesn't use any himself, while still another has refused to follow the cry for geared drives and has his own line of trade where cone-driven tools are always called for. More than that he has several geared machines of other makes in his shop, and in ordering new machines has absolutely refused to consider gear drives at all. It's either a cone-driven machine or some other man gets the order.

It's a wise man who can pick the winning type or kind of drive just at this time, but it's a harvest of ideas for the designer, and young draftsmen should be getting ideas on gear combinations that will be worth dollars in many other lines of work.

An Official Critic

The Lodge & Shipley Machine Tool Company, of Cincinnati, Ohio, have adopted a somewhat novel plan to improve and perfect their lathes to the highest point. They have secured J. E. Bennett, well known among tool builders of the East, to act as a general improver and criticizer. His mission is to add and perfect details in design, whether they be large or small with the object of making the lathes more attractive as well as better in mechanical details. He has nothing to do with production and works independently of the shop organization, making recommendations direct to Mr. Lodge.

In addition to this, and working along the line of impressing or suggesting ideas until they become unconsciously fixed in the mind, they have had a lot of special signs made, of blue enamel with white letters about 2 inches high. These are very neat and bear the legend

QUALITY FIRST.

These will be fastened up in all the departments so as to impress the men with the idea that the first aim is not quantity but quality.

Geared Head Lathes in the Tool Room

When it comes to taking their own medicine this shop can show many examples. Perhaps the most striking is the use of geared-head lathes in the tool room in place of the usual light, cone-driven lathe. The argument is that you occasionally need heavy reductions even on tool work, that you always need a good range of speeds and that you get both of these more conveniently and more quickly in this way than any other. Then in handling work in the chuck or on the face plate, a touch releases the friction and the work can be swung into any position without pulling around with the belt.

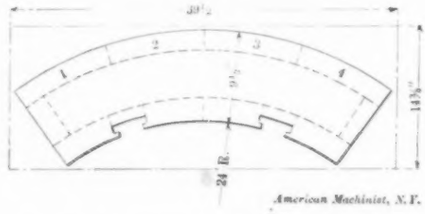
They have also put their geared countershaft into use very generally on machines of all kinds, from milling machines to planers indicating their belief that it gives the desired speed changes without trouble of any kind. F. H. C.

Hardening a Die for Punching Armature Segments

By Ralph W. Davis

A number of articles have recently appeared in the American Machinist on the hardening of steel, the manner of measuring hardness and also the peculiar things that a piece of steel will do sometimes in hardening.

The articles are especially helpful to we fellows who use such steel quite often, but not often enough to feel on intimate terms with it, and so we are often shocked and perhaps "pained" by an unsuspected



DIE FOR PUNCHING ARMATURE SEGMENTS

occurrence while making up a costly set of dies.

In spite of all available data I am still seeking an explanation of the following incident:

We were getting out a blanking punch and die of the size and shape shown in the line cut. The dot-and-dash lines show the size of stock used. The full lines show the desired blank punching. The dot lines show outline of steel dies. These latter were made up in sections because of the large size, and were seated in a heavy cast-iron bed. There was nothing unusual in the construction except the size.

Sections 1, 2, 3 and 4 being ready for hardening, were treated exactly alike, but only one at a time. Nos. 1 and 2 came along all right. No. 3 came from the oil bath, apparently a duplicate of Nos. 1 and 2. It was laid on an anvil and after a moment broke in two pieces; the toolmaker picked up a piece and it broke in several pieces. I picked up a piece from this second break and after holding perhaps a minute this again went to pieces.

Every fracture evidenced considerable force as fragments were thrown several feet.

The first fracture was easy to explain as being due to placing heated steel on a cool anvil, but the other cases when the steel was cool enough to handle seem peculiar. We had no trouble with the new section which replaced this one.

As to further operations on the blank punching: It required five segments to make the complete armature disk with 200 slots each 29/16 inches deep by ½ inch wide. We made a special revolving table with keys to fit the internal slots of the blank and attached it to a Bliss notching press with indexing attachment, thus punching one slot at a stroke. This rig enabled a boy to remove the finished segment, place a blank and keep the circle complete without stopping the machine, and all segments were interchangeable.

The first electrometallurgical plant for making tool steel in Russia has just been installed at the Oboukhoff works, near St. Petersburg. Professor Lipine, after visiting most of the plants of this nature in other countries, decided that the Heroult system was the best adapted for the purpose, and the present equipment is of that type.

Forthcoming Meetings

American Hardware Manufacturers Association, joint convention with Northern Hardware Jobbers Association, Pittsburg, Penn., June 9-11, headquarters, Hotel Schenley. F. D. Mitchell, secretary, 309 Broadway, New York City.

Engineers Society of Pennsylvania, first annual convention, Harrisburg, Penn., June 9-10-11, headquarters, Capitol building; E. R. Dasher, secretary.

Railway Master Mechanics Association, annual convention, June 16-18, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

Master Car Builders Association, annual convention, June 21-23, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

National Gas and Gasolene Engine Trades Association, meeting, June 22, 23, 24, South Bend, Ind., headquarters, Oliver hotel. Albert Steitwatter, Cincinnati, Ohio.

Society for the Promotion of Engineering Education, seventh annual convention, June 24-25-26, Columbia University, New York, and Pratt Institute, Brooklyn, N. Y. Arthur L. Williston, secretary, Pratt Institute, Brooklyn, N. Y.

American Society of Testing Materials, annual meeting, June 29, Atlantic City, N. J., Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Penn.

Business Items

The name of the Lincoln Motor Works Company, Cleveland, O., has been changed to the Reliance Electric and Engineering Company. The management will remain the same.

The Miami Valley Machine Tool Company, manufacturer of lathes and sensitive drills, and the Dayton Machine and Tool Works, manufacturer of griding machines for tool room and manufacturing, both of Dayton, Ohio, have consolidated their business and will adopt the name of the former company. David Wilson, who has been sole owner of the Dayton Machine and Tool Works, will be actively connected with the new company, and will continue giving his personal attention to the building of the Dayton grinders, as well as the Miama Valley lathes and sensitive drills.

Business Opportunities

W. E. Fuller, Oswego, N. Y., will build a new blacksmith shop.

The Oil City (Penn.) Boiler Works is building a new boiler shop.

L. C. Tarras, Winona, Minn., will build an addition to his foundry.

The Shore Electric Company, Red Bank, N. J., will build a new power plant.

The Milwaukee (Wis.) Bridge Company is building an addition to plant.

T. M. Smith & Co., Peoria, Ill., machinists, will build an addition to plant.

The Memphis (Tenn.) Bag Company will erect a new five-story factory.

The Des Moines (Iowa) Paper Box Company will erect a new factory building.

The Jackson (Mich.) Motor Car Company is erecting an addition to plant.

The West Penn Steel Company is building a new plant at Brackenridge, Penn.

The Petrel Motor Car Company, Kenosha, Wis., will erect a new $50,000 plant.

The Lennox Furnace Company, Marshalltown, Iowa, will build an addition to foundry.

The Western Pacific Railroad will erect roundhouse and machine shop at Oakland, Cal.

The F. Mayer Boot and Shoe Company, Milwaukee, Wis., will build a new power plant.

The Michigan Crucible Steel Castings Company, Detroit, Mich., has bought site for a new plant.

Fire in plant of the Canada Saw and Lead Works, Montreal, caused a damage of $150,000.

An addition will be built to the foundry of the General Electric Company, at Schenectady, N. Y.

The Worcester Pressed Steel Company, Worcester, Mass., has had plans prepared for a new plant.

The Auto Press Company, College Point, N. Y., is said to be contemplating enlargement of plant.

The Household Granite Tub Company, New Haven, Conn., is having plans drawn for a new plant.

The Winchester Repeating Arms Company, New Haven, Conn., will build an additional factory.

The North & Judd Manufacturing Company, New Britain, Conn., is to build a new foundry addition.

The Arlington Corporation, Lawrence, Mass., is starting work on a new yarn mill to cost $1,000,000.

The C. J. Root Company, Bristol, Conn., making counting machines, etc., will erect a new plant.

The Lawrence Manufacturing Company, Lowell, Mass., is erecting a $110,000 addition to its hosiery plant.

Gold & Weinberg, New Britain, Conn., will build an addition to their repair works and carriage shop.

The Robert A. Johnston Company, Milwaukee, Wis., baker and confectioner, is to build a six-story addition.

The plant of the Reid Foundry and Machinery Company, Ingersoll, Ind., was burned. Loss, about $10,000.

The Lake Erie Forging Company, Cleveland, Ohio, will erect a new plant and will need additional machinery.

The American Woolen Company is building a new mill at Lawrence, Mass., to cost more than $3,000,000.

Fire destroyed the plant of the Memphis (Tenn.) Cotton Oil Company, causing a loss of $150,000. It will be rebuilt.

The United Illuminating Company, Bridgeport, Conn., has awarded contract for a one-story brick power house.

The Crocker-Burbank Company, Holyoke, Mass., manufacturing writing paper, is erecting two new buildings.

The New York Central Railroad has awarded contract for the erection of a $500,000 machine shop at Albany, N. Y.

The Danville and Western Railway Company, Danville, Va., is in the market for an engine lathe, 24 inches by 8 feet.

The Milwaukee (Wis.) Linseed Oil Company is installing new boiler and making other improvements in power plant.

The Central Automobile Company, Vancouver, B. C., would like catalogs from builders of machine tools and garage equipment.

The Hale & Kilburn Manufacturing Company, Philadelphia, Penn., furniture makers, will erect a new $100,000 factory.

The Western Motor Company, of Logansport, Ind., is to move to Marion, where a plant to cost $150,000 will be erected.

The Powers Paper Company, of Holyoke, Mass., will erect a factory in Springfield for the manufacture of envelops.

D. J. Murray Manufacturing Company, Wausau, Wis., is building an addition which will double the capacity of foundry.

E. B. Van Wagner & Co., Syracuse, N. Y., making metal castings, etc., are building a new plant at Fayetteville, near Syracuse.

The Strubler Computing Scale Company, Elkhart, Ind., has commenced work on new building near entrance to Island Park.

The McKeesport Tin Plate Company will double capacity of plant at Port Vue, Penn., by the erection of an additional building.

The Bousefield Woodenware Company, Minneapolis, Minn., will move to Aberdeen, Wash., where site has been secured for a new plant.

The Georgia, Southern & Florida Railway has started work on the enlargements of shops at Macon, Ga. Improvements will cost $250,000.

The Le Mars (Iowa) Water and Light Company is planning to put in a new generator changing from 120-cycle to 60-cycle direct belted.

The St. Louis Southwestern Railway is said to be planning enlargement of machine shops at Tyler, Texas. M. L. Lynch, Tyler, chief engineer.

The plant of the Dundee (N. Y.) Manufacturing Company, manufacturing brass goods, plumbing supplies, etc., was burned. It will be rebuilt.

The Phillips & Brittorff Manufacturing Company, Nashville, Tenn., stove manufacturer, it is said, will erect a new foundry in South Nashville.

The Gus Peche Foundry and Machine Company, Le Mars, Iowa, will rebuild shop. A new woodworking and a new ironworking lathe will be installed.

The Altus, Roswell & El Paso Railway has, it is said, secured site at Memphis, Tex., for shops, roundhouse, etc. Edward Kennedy, Altus, Okla., president.

The Indiana Rubber and Insulated Wire Company, Jonesboro, Ind., will erect a three-story addition and, it is said, engage in the manufacture of automobile tires.

E. O. Rogers & Co., San Diego, Cal., carriage manufacturers, have let contract for the erection of a new factory, and will probably engage in the manufacture of automobiles.

The International Harvester Company is to make improvements at plant in Sterling, Ill., to cost nearly $75,000. New machinery is to be installed in the blacksmithing department.

The American Bank Note Company is about ready to commence construction of its immense new plant in the Hunt's Point section of the Bronx, New York. The building will cover an entire block.

The Isthmian Canal Commission, Washington, D. C., will receive bids until 10:30 a.m., June 21, for lathes, surface condensers, pumps, hose, leather belting, steel and malleable iron castings, steel, belts, rivets, valves, lubricators, wrenches, tool holders, pipe cutter wheels, etc., as per Circular No. 514.

Proposals will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until 11 a.m., June 26, for one locomotive jib crane of 40 gross tons capacity, for the Norfolk (Va.) Navy Yard. Specifications can be obtained at the Bureau or of the commandant of the Navy Yard.

Proposals will be received at the Bureau of Yards and Docks, Navy Department, Washington, D. C., until 11 a.m., June 26, for motor generator sets, exciters, switchboard, etc., for the Navy Yard at Philadelphia. Specifications can be obtained at the Bureau or Navy Yard.

The Navy Department, Bureau of Supplies and Accounts, Washington, S. C., will open the following bids: June 15—tool steel (schedule 1306), electric elevators (schedule 1310), feed-rod machine (schedule 1309), nickel steel rollers (schedule 1294); June 29—electric traveling hoist, electric elevator (schedule 1304).

The Chesapeake and Ohio Railway is said to be considering improvements to shops at Huntington, W. Va., including extension of machine shop and car repair shop, involving an expenditure of about $300,000. F. I. Cabell, Richmond, Va., engineer maintenance of way.

The Concrete Block and Supply Company, Wausau, Wis., is building a large addition to plant.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., June 14, for centrifugal pump and engine, portable rock crusher, motor car, gasolene motor, transformers, electric hoist, horizontal boring and drilling machine, vertical hollow chisel mortising and boring machine, rotary splitting shear, belt-driven horizontal punch, portable pneumatic riveter, hand bolt cutters, triplex blocks, crucibles, horse-clipping machines, tire shrinkers, as per Circular No. 512.

New Incorporations

The Helena (Ark.) Box and Lumber Company has been incorporated with $400,000 capital.

The Castle Cotton Mills, Ltd., Knoxville, Tenn., is being incorporated with $1,000,000 capital by William T. Lang and others.

The National Filter Company, Chicago, has been incorporated with $25.000 by Jos. E. Ryan, Unity building, Chicago, Ill. Will manufacture filters.

The Herculoid Paper Company, Hoboken, N. Y., has been incorporated to manufacture paper. Capital, $100,000. Incorporators, Geo S. Ridner, Geo. A. Hill, E. W. Arrowsmith.

Albany Malleable Iron Company, Albany, N. Y., has been incorporated. Capital, $150,000. Incorporators, W. E. Woolard, Albany; F. V. Griesman, Voorheesville; G. L. French, Troy.

Central Garage Company, Newark, N. J., has been incorporated to do a general automobile garage and repair business. Capital, $10,000. Incorporators, David Wyllie, John Swan, Louis F. Aldig.

The Litchfield Iron Works, Litchfield, Ill., has been incorporated to do a general foundry and machine shop business. Capital, $12,000. Incorporators, Alex. W. Crawford, Wm. P. Crawford, Chas. C. Terry.

The Howard Metal Company, Jersey City, N. J., has been incorporated to manufacture metal bearings, etc. Capital, $250,000. Incorporators, H. O. Coughlan, S. A. Anderson, B. F. Mantz.

Harris H. Uris Iron Works, New York, has been incorporated to manufacture structural and ornamental iron, sheet and metal work. Capital, $25,000. Incorporators, H. H. Uris, A. Uris, M. Uris.

Phineas Jones & Co., Newark, N. J., have incorporated to manufacture wheels, hubs and tires. Capital, $100,000. Incorporators, Henry Jones, Phineas Jones, H. Percy Jones, 45 North Broad street, Newark.

Crown Metal Construction Company, Jamestown, N. Y., has been incorporated with $75,000 capital to manufacture metal furniture, etc. Incorporators, D. Lincoln, J. Wormberg, M. R. Nelson.

The Muelhauser Machine Company, Cleveland, Ohio, has been incorporated to manufacture automobiles. Capitol, $15,000. M. W. Muelhauser, president; H. S. French, of the Machinery Forging Company, secretary and treasurer.

The Scott Fountain Pen Company, Jersey City, N. Y., has been incorporated to manufacture fountain pens, etc. Capital, $750,000. Incorporators, F. Whitecar, Newark, N. J.; J. O. Seifert, Brooklyn, N. Y., N. M. MacDonald, New York.

New Catalogs

J. A. Rose, Hastings, Neb. Circular illustrating and describing Rose washer and gasket cutter.

Walden Manufacturing Company, Worcester, Mass. Circulars illustrating and describing Walden ratchet wrench.

The Ready Tool Company, New Haven, Conn. Catalog of Red-E-Tool Holders. Illustrated, 12 pages, 3½x6 inches, paper.

Beaudry & Co., Inc., Boston, Mass. Catalog describing Champion power hammer. Illustrated, 3½x6 inches, 12 pages, paper.

Fox Machine Company, Grand Rapids, Mich. Catalog No. 92, describing tube or pipe cutters. Illustrated, 12 pages, 6x9 inches, paper.

Webster & Perks Tool Company, Springfield, Ohio. Catalog of modern grinding and polishing machinery. Illustrated, 16 pages, 6x9 inches, paper.

The "Long-Arm" System Company, Cleveland, Ohio. Bulletin No. 27, describing "Long-Arm" tooth chamfering attachment. Illustrated, 8 pages, 6x9 inches.

The Bristol Company, Waterbury, Conn. Bulletin No. 103, describing recording instruments especially adapted for blast furnaces. Illustrated, 16 pages, 8x10½ inches.

Multiple Woven Hose and Rubber Company, Worcester, Mass. Circular describing "Best" waterproof belting and pamphlet describing solid multiple woven waterproof belting.

Reeves Pulley Company, Columous, Ind. Engineers' Manual of "The Reeves" Variable Speed Transmission. Illustrated, 58 pages, 3½x6 inches, leather, price $1, paper bound, free.

Brown & Sharpe Manufacturing Company, Providence, R. I. Booklet entitled, "Features of the Original Constant Speed Drive Milling Machine." Illustrated, 28 pages, 6x9 inches, paper.

International Steam Pump Company, 115 Broadway, New York. Bulletin W 165 on Worthington volute centrifugal pumps. Bulletin W 166, on Triplex house tank pumps and Bulletin W 169, Worthington boiler feed pumps. Illustrated, 6x9 inches.

S. W. Card Manufacturing Company, Mansfield, Mass. Pamphlet, "Standard Sizes and Pitches of Threads for Taps and Dies," containing article on "Proposed Elimination of the Old V-Thread in Taps and Dies" and editorial, "The Passing of the V Thread," reprinted from the AMERICAN MACHINIST. 22 pages, 4½x7 inches.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

Test indicators. H. A. Lowe, Cleveland, O.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

A large foundry and machine shop desires to add to present lines of manufacture. Box 126, AMERICAN MACHINIST.

Bench lathe clamp dogs, ¾-inch, $1.00; 1-inch, $1.25; 1½-inch, $1.50; hardened, polished. W. H. Nichols, Waltham, Mass.

Wanted—Prices and information for making flexible tubing for automobile horns. Box 283, AMERICAN MACHINIST.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—To manufacture, in modern fireproof machine shop, small specialties in brass or iron. Box 273, AMERICAN MACHINIST.

If you have a new and specially good article to sell to machine shops in and near New York I can get the orders. Write Box 261, AM. MACH.

We want some small specialties to start a new manufacturing enterprise; machine or automobile features preferred. Address "Specialty," AMERICAN MACHINIST.

Lathe and machine work of every description, patterns, gear cutting, screw machine work, iron, brass and aluminum castings. The Sipp Electric & Machine Co., Paterson, N. J.

Wanted—Firm to manufacture duplicate parts or the completed articles of a line of small drop-forged tools on contract and in quantities as desired. Box 260, AMERICAN MACHINIST.

Tool holder—replaces any two holders now on market, can be used for boring and turning, also saver of labor and steel. For further particulars address "J," Box 24, Laurium, Michigan.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Wanted—From 500 to 1500 horsepower of B. & W. water tube boilers in units of 250 horsepower each. Must be in A-1 condition. Inquire of J. F. Cargill, Room 1630, Frick Building, Pittsburg, Pa.

An Unusual Turret Lathe Equipment

How Large Ball and Socket Joints, Valves, Valve Seats and Connections Are Machined on Standard Turret Lathes with Special Tools

BY C. L. GOODRICH*

The accompanying engravings illustrate a class of work which is somewhat out of the ordinary and for the machining of which the Pratt & Whitney Company, of Hartford, Conn., has equipped seven of its standard 2½x26-inch open turret lathes, these being supplied to the Hartmann Locomotive Works, Lugansk, Russia. These machines have been fully described in the columns of the AMERICAN MACHINIST and no further remarks on the machines proper are required excepting to note that they are equipped with lead screws for the turret slide so as to adapt them for heavy threading operations. Provision is made to obviate the simultaneous "throwing in" of the regular power feed of turret slide and the lead screw.

In Fig. 1 is shown the work that the machines are equipped for finishing; namely, balls and sockets, valves and valve seats and threaded connections. The work is made in various sizes from 4½ inches in diameter to 12 inches and is of boiler-iron, cast-iron and semi-steel castings. The fits required between the ball and its socket and also in the male and female threads are such that they will not permit of leakage of naphtha when assembled and no excessive amount of "grinding in" will be necessitated.

The work being largely of tubular cross section and somewhat long required novel means of holding so as to avoid distortion and to prevent all possibility of the work being released from the chuck during the heavy cutting operations. Some of the pieces required two distinct operations and thus two separate holdings or chuckings were necessary, which called for chucks that would hold their truth where concentricity was a factor and in other cases where concentricity was not so highly important provision for redressing the gripping surfaces of the chuck was desirable and hence provided for an incidentally insured concentricity also.

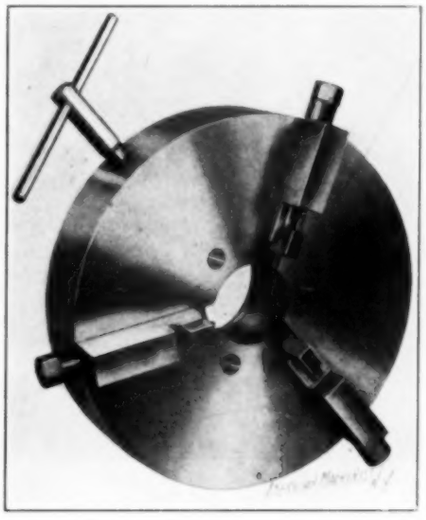


FIG. 2. SCROLL CHUCK WITH EXTERNAL AND INTERNAL JAWS FOR GRIPPING TUBULAR WORK

Fig. 2 illustrates a three-jawed geared scroll chuck equipped with special jaws having three drawback or hook bolts so that in gripping the slender tubular work no danger of distortion exists as in use the periphery of the work is only lightly gripped or centered by the three jaws and then securely clamped to each jaw by the tightening of a nut which draws the hook bolt into contact with the interior of the work and thus anchors it firmly to the chuck. This construction which is shown in detail in Fig. 3, enables very heavy operations to be accomplished and it is doubtful whether even a solid casting could be held as rigidly; and yet no springing of the tubular work results. A double gripping chuck jaw for one of the castings which is of spherical form both outside and inside is represented by Fig. 4. The work is shown in place in the chuck in Fig. 5. There are, of course, three of these jaws and they are used first, in centering the work from the inside and then clamping the work by the three outside set screws. The jaws are used in the same type of chuck as shown by Fig. 2 and hold the work securely with no distortion.

FIG. 1. WORK MACHINED ON PRATT & WHITNEY 2½x26-INCH OPEN TURRET LATHES WITH SPECIAL EQUIPMENT

Fig. 6 shows a chuck with soft threaded jaws for second-operation work and their use permits of gripping the piece much more securely than by solid threaded ring chucks which have no adjustment for wear. The work in addition to being gripped by the threaded portion is supported by the three screws, one in each

*Department foreman, Pratt & Whitney Company.

jaw, as shown. The spherical turning attachment illustrated in that view will be referred to later.

Figs. 7 and 8 illustrate a chuck which the Pratt & Whitney Company has developed for large gun work and which is very satisfactory for holding work by finished surfaces as it not only has ample gripping power but holds work concentrically. The chuck body *a*, Fig. 8, which

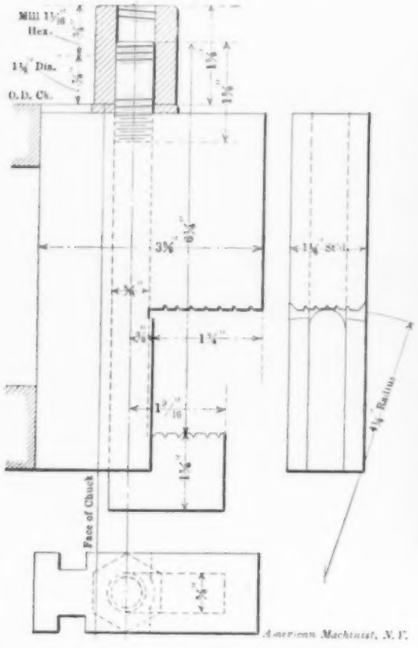


FIG. 3. DOUBLE-GRIP CHUCK JAW FOR TUBULAR WORK

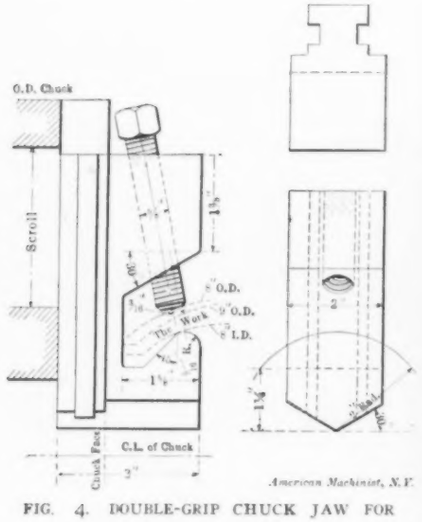


FIG. 4. DOUBLE-GRIP CHUCK JAW FOR SPHERICAL WORK

is screwed onto the head spindle of the lathe, is bored conically to receive a split bushing *b* of suitable size to hold the work. The exterior of the bushing is conical but relieved so as to permit of its being cylindrically closed internally when it is drawn into the conical seat in the body by means of the internally threaded ring *c* which is provided with two half circle plates *d* and *d'* that engage in the circumferential groove of the conical bushing as represented. These plates, in connection with the threaded ring *c*, provide means for positively moving the bushing in either direction and so a slight angle for the cone is possible with increased gripping power. The bushing is split alternately from each end and is keyed so as to prevent rotation within the body. A bar is used to operate the threaded ring. This chuck is satisfactory on both solid and tubular work and no distortion in its use on the latter results as it fully encircles the work.

The threading toolholder shown in Fig. 5 is illustrated more clearly by Fig. 9. It is held on the cross-sliding turret and consists of a body and a tool block carrying slide which is operated radially by an eccentric sliding block and lever permitting the instantaneous withdrawal of the threading tool from the work at the end of the thread, while at the commencement of each traverse during the chasing operation the cross-sliding turret only is moved forward radially to give the depth of cut and it is not necessary to withdraw the slide until the full depth of thread is cut. This scheme, as will be recalled, has pre-

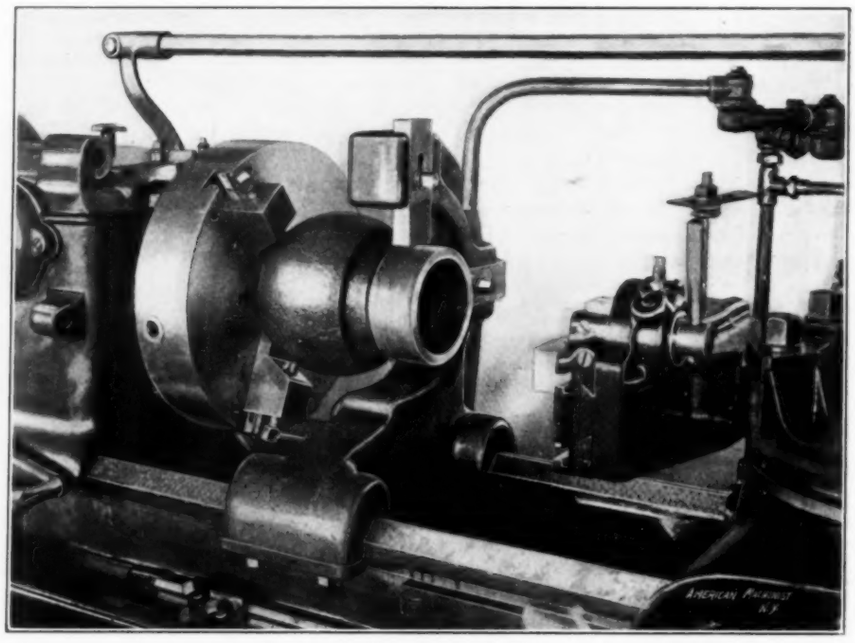


FIG. 5. HOLDING SPHERICAL WORK WITH DOUBLE-GRIPPING CHUCK JAWS

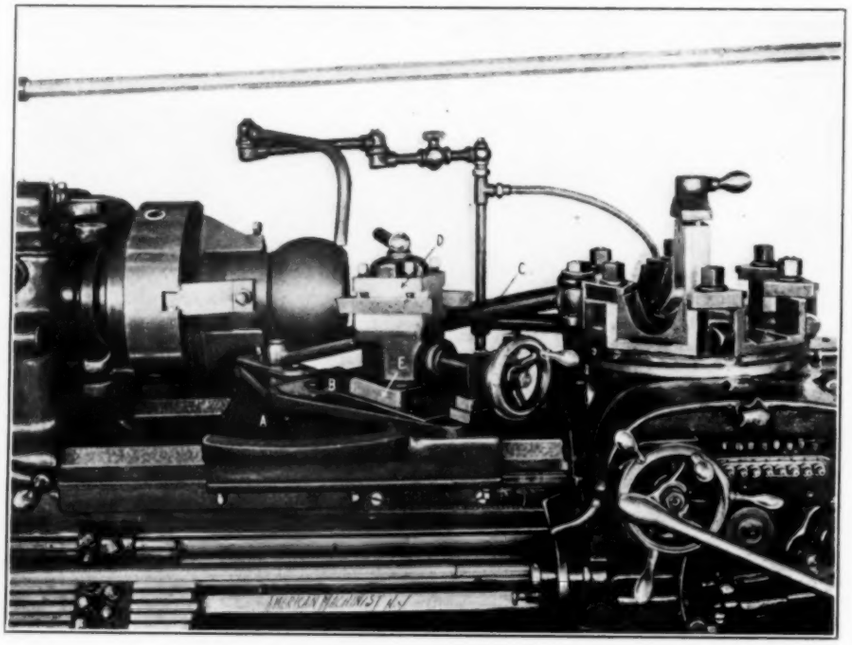


FIG. 6. A CHUCK WITH THREADED JAWS FOR HOLDING THREADED WORK AND A SPHERICAL TURNING ATTACHMENT

viously been applied to the Pratt & Whitney 16-inch toolmakers lathe.

This threading tool is used for cutting both outside and inside threads. On outside work the spindle is run in the usual direction while on internal work it is operated in the reverse direction, the cut starting nearest to the chuck and the feed being outward. The strain on the cutting tool in this case is a pulling one and is found in practice to result in lessened vibration and chattering. The work gripping chuck is securely fastened to the spindle so as to prevent its unscrewing while threading with the spindle running backward. The block for holding the threading tool may be located and clamped at any desired point on the slide to suit the position required by the work and thus allow the positive cross-slide stop of the turret to be used for the threading operation. It is only necessary to locate the tool block approximately as minute setting of the cross slide is effected by an eccentric adjustment. Some of the work is quite long and projects such a distance from the spindle bearings as to make the use of a back rest advisable during the threading cut. The back rest is shown by Fig. 5, the jaws being set into contact with the work after the turning of the outside.

The spherical turning fixture shown in Fig. 6 has a base *A* which is clamped to the bed of the turret lathe, and a pivoted tool slide plate *B* which is swung by means of a link *C* attached to the turret slide, the feed of the turret slide thus being utilized to swing the plate. There are provided two cutting tools, one for roughing and one for finishing. The tools are held in a block *D*, which is mounted on a stud so that the tool desired is readily presented to the work by unclamping the binder handle and rotating the block. Radial adjustment is effected by the slide *E* carrying the tool block, this slide being traversed by hand wheel and screw. Rigid binding of this slide is provided for and there is also an external gib for the swinging plate *B*. The pivot upon which the plate swings is located so that its axis is in line with the spindle and hence perfectly spherical work is produced.

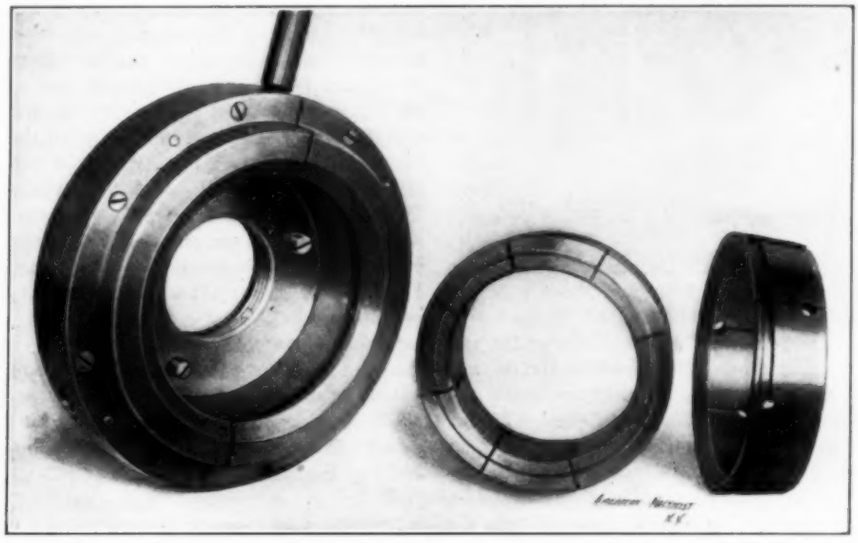


FIG. 7. LARGE SPRING CHUCK

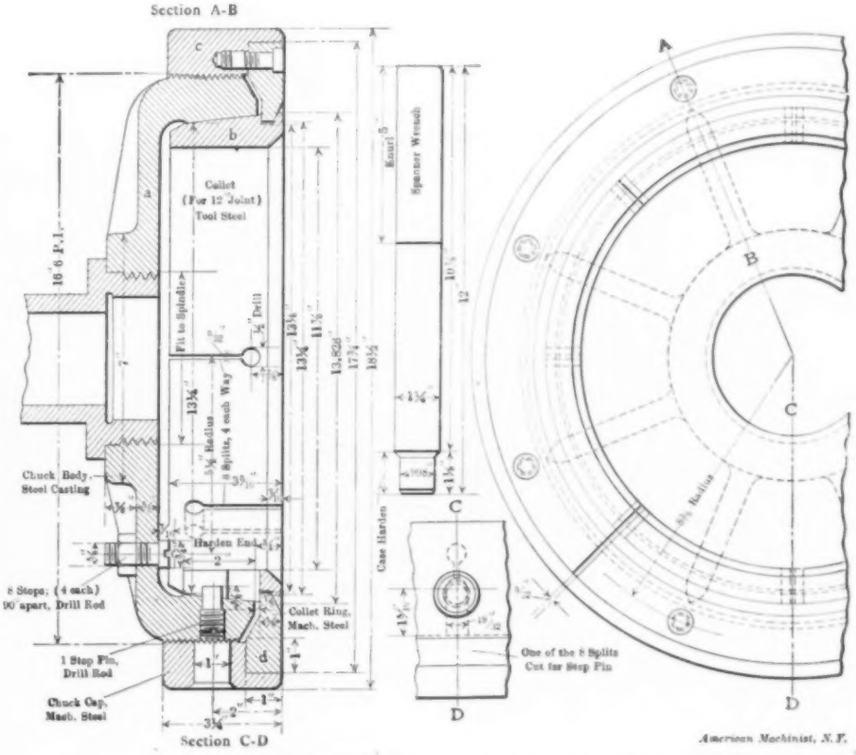

Section A-B
Collet (For 12 Joint) Tool Steel
Chuck Body, Steel Casting
Hardened End
8 Stops; (4 each) 90° apart, Drill Rod
Collet Ring, Mach. Steel
1 Stop Pin, Drill Rod
Chuck Cap, Mach. Steel
Section C-D
Case Hardened
One of the 8 Splits Cut for Stop Pin
American Machinist, N.Y.

FIG. 8. CONSTRUCTION OF LARGE SPRING CHUCK

A spherical boring fixture is shown on the machine in Fig. 10. It is similar in design to the external fixture in Fig. 6 and will be understood from the illustration. This engraving also shows a group of tools forming part of the equipment described.

Echoes from the Oil Country—A New Variable Speed Invention

By W. Osborne

"Do you know, Osborne, I have thought up a fine thing. I can't imagine what is the matter with you mechanics. Here you have been working away and spending time and money and brains trying to get up something that will give you variable speeds. Look at the things that they call gear boxes that every automobile has to have, and then look at the quick-change devices used for the feeds of lathes and other tools, and then look at the variable-speed countershafts, and when you get tired of looking at those monuments of wasted time and energy just listen to me for a few seconds. I will show you that it takes a man who is not a mechanic to really see things. If you see something that you never saw before, or that you never read about you say, 'That is not mechanical,' and run away scared."

My friend had well said, in his own roundabout way, that he was not a mechanic. I had known him for some time, but had never felt disposed to try to convince him that he was one, but then even an unmechanical man may stumble upon something mechanical. Besides that, there is no chance to get away from him.

"If you have your idea fully covered by letters patent perhaps you will not object to telling me what it is," I ventured.

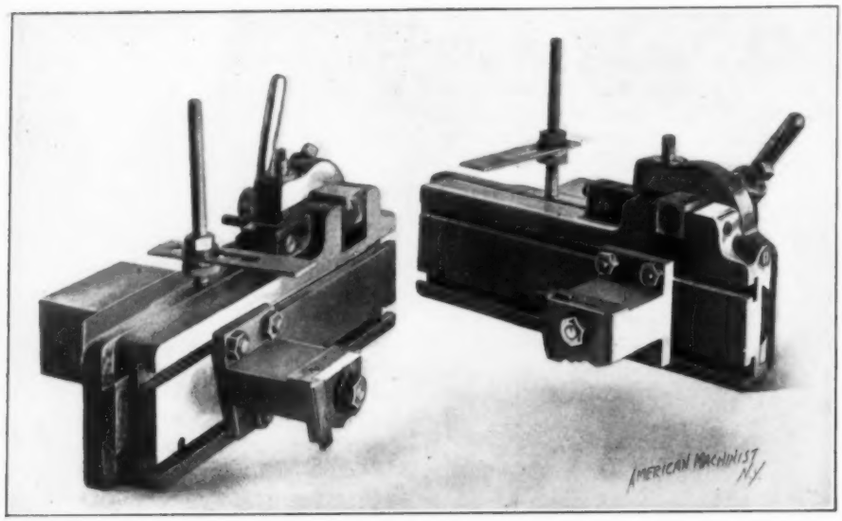


FIG. 9. THREAD TOOL HOLDERS FOR TURRET

"I will tell you about it for I want a little information about how to best apply it to some of the various purposes to which it is so admirably adapted." That seemed to be a sort of figure of speech, for it seemed somewhat as though he wanted my help to arrange the adapting.

"Go on with your explanation," I said.

My Friend's Explanation

"I know that you do not own an automobile, but, of course, you know something about them. Some of them have a little dynamo to make the spark, and there is one kind that has a little pulley that is turned by rubbing on the flywheel of the engine. This dynamo should run at the same speed all the time while the engine runs all sorts of speed. If the flywheel tries to make the dynamo run too fast a little governor device of the dynamo pulls the little pulley away a little bit and it slips enough to keep the speed of the dynamo regular, no matter what the speed of the engine is. It works fine. My idea is to reverse the operation. What is the matter with running the driver at a constant speed and varying the speed of the thing being driven? Hold on a minute, now. Just you listen with an open mind, if you can, and don't say anything about a governor designed to give variable speeds. I have it and it is perfect.

"You may hunt for 1,000,000 years and yet you will never find anything better. It isn't to be found. Take an automobile, for instance. The engine is started, and to start the machine the clutch is thrown in. All that is needed is means of accurately adjusting the amount that it is thrown in. At one end of the movement the clutch is entirely disengaged and at the other end it is in so that there is not any slip. Between these points are all the variations there are. The car can be run at anything from full speed to nothing. You are a mechanic and so you understand more about the places where it can be applied in the shops and factories than I do. That is why I came to talk to you about it.

"There is another great point about it that you must not overlook. It is to some extent a safety device. When it is set for a speed on a machine and something gets caught or jams in the machine, instead of tearing things to pieces the clutch just slips some more.

"Now for the governing device. It is the man who is running the machine. You will have to admit that a man is a better device than any machine. The man who is running an automobile has to constantly manipulate the steering wheel and he will manipulate the clutch the same way. As the engine will run at the same

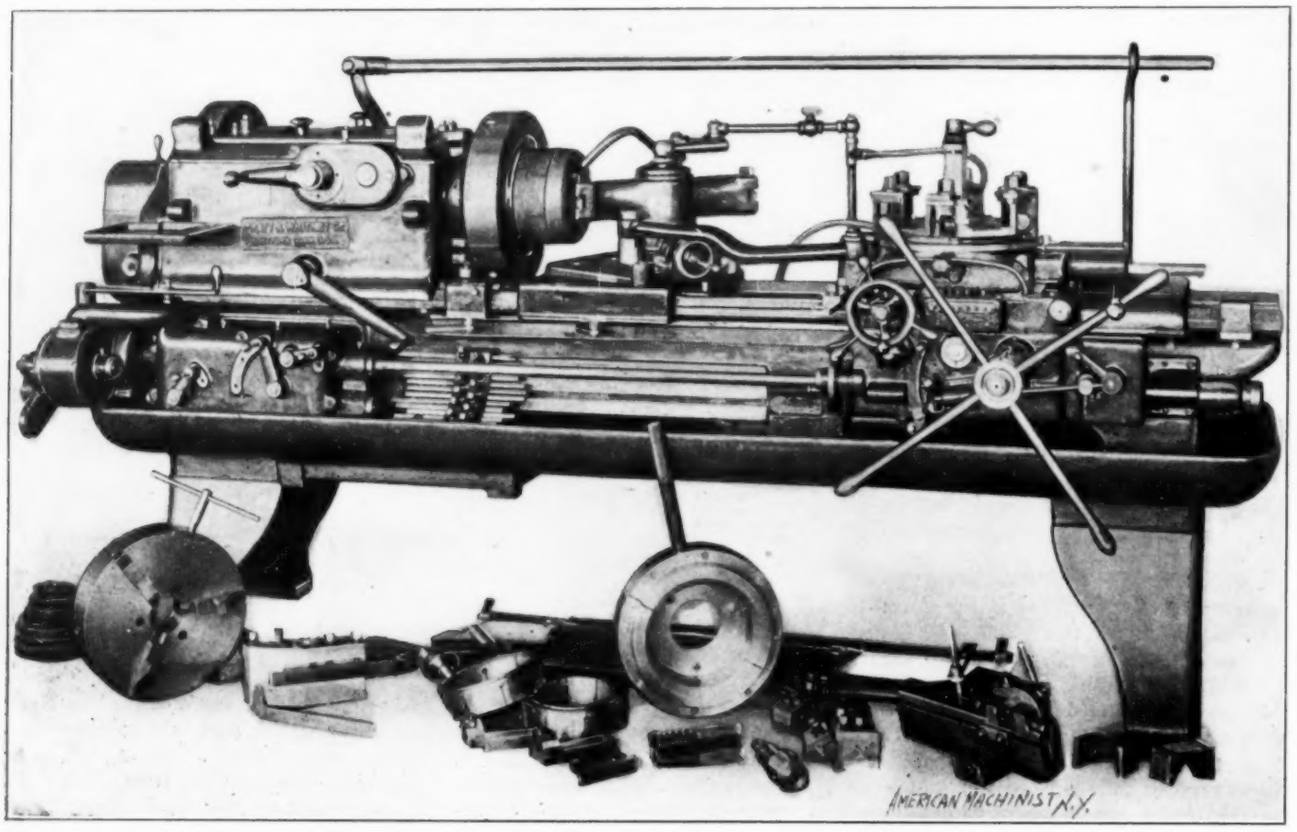


FIG. 10. PRATT & WHITNEY 2½X26-INCH OPEN TURRET LATHE WITH SPHERICAL BORING ATTACHMENT AND OTHER SPECIAL TOOLS

speed all the time he will not have to pay any attention to that except to see that it is getting oiled properly so he will handle the clutch instead of fussing with the spark, the carbureter feed and the speed-changing lever. If a man is running a machine that requires variable speeds in a shop he is right there at the machine while he is doing it and can run at exactly the speed that his judgment tells him is best and do it a whole lot easier than he can move a belt on cone pulleys, or pull a lot of levers and knobs and handles on a speed box. After he does change with the present devices it is not very often that he gets what he wants.

"Wear? Of course it will wear. I know it will, but what do a few wooden blocks, or pieces of fiber, or a little metal amount to. Make the clutches so that the parts that wear can be replaced easily.

"You take time enough to think this over before you come to a conclusion. Lots of trained mechanics have a way of getting on to the wrong side of new things and then not know how to get off again."

In spite of the rather unkind digs that my friend had given to my mechanical dignity he had given me a new subject to think about and I have been doing some.

My Ruminations

The first question that came into my head concerning such a friction drive was whether it could be manipulated so as to get accurate changes of speed under varying conditions. After thinking over all of the places I could remember where I had seen frictions used to get changes of speed I decided that this point could be taken care of. The question of durability is one of materials and of area of surfaces and could be taken care of by the designer.

Having had some experience with gas engines which have to use a clutch in starting, I have had some experience with slipping clutches. That experience has shown to me that it takes more power to pull a load partly up to speed with a clutch slipping than it does to pull it at full speed with the clutch holding. It has often happened that an engine that had been pulling a load right along seemed to get weak and even stop with the same load and an expert from the shop would be sent for. After he tightened the clutch the engine would be as strong as ever and pull the load.

To illustrate the point I took a smooth board and fastened a pulley at one end of it. A block of wood was laid on the board and a string fastened to it. The string was led along the board and over the pulley so that it hung vertically. On the vertical end of the string enough weight was hung to just move the block from a standstill. A very little weight on the block would keep it from starting. After it had started it took an additional weight to stop it. The faster it was going before the additional weight was put on the more the weight had to be to bring the block to rest. In no case would the weight that would just hold the block securely at a standstill bring it to rest after it had once started to move along the board. This experiment would seem to confirm the belief of the gas-engine experts that it was harder on the engine to drive its load with a slipping clutch.

My Imaginary Automobile

I imagined that I had an automobile. One of these nice new 40-horsepower fellows that would really develop about 24 machinist's horsepower of 33,000 foot-pounds per minute. (Somehow or other I can't get much of a grip on the thing that the auto expert calls a horsepower, and that is found by squaring the diameter of the cylinder, multiplying by the number of cylinders, and dividing by something, and that lets them call my nice new imaginary car a 40-60.) This nice car will go 40 miles an hour at top speed on the pavement when there isn't a policeman anywhere around, and the people in the neighborhood don't know me; but my grandmother is to have a ride. She is not used to these new-fangled ideas and I have to promise not to go faster than five miles an hour.

That means that after I have been going for some time I may creep up to eight, or possibly 10 miles, but that will be the limit. The engine is skipping blithely along, ready and willing to send the car the 40 miles an hour, but the car is going only 10 miles an hour. The clutch has to absorb the 30 miles that is coming from the engine, but is not being used by the car. It has to take care of the heat equivalent of at least three-quarters of those 24 real horsepowers. I begin to fear that in giving her that ride in my nice new car I shall make it rather hot for my grandmother, and the slower and nicer I try to run the hotter it will be. Unless I can find an excuse and have her get out awhile while I speed up to the top notch and run around and cool off we are likely to go up in spontaneous combustion before we get back home. One claim on this invention should be for a combined speed-variator and heater.

There is another little point that is bothering me about that car. I get a prospective customer in it and shoot away out into the country and back. We go uphill and down and always at the highest speed we can. We are gone three hours and use up 12 gallons of gasolene. I don't mind that for the ride jarred out a nice big order. Then I take my grandmother and we creep around the town and I keep looking back for fear a wagon will run into us, I am not very well pleased to find that I am still using 4 gallons of gasolene an hour. I am willing to trade that car for one that bobs the springs up and down, and that goes from one speed to another with a jump, and that snorts and rattles so that a horn is not needed.

Maybe it would be economical to turn heat into horsepower and then to turn it back into heat at the machine to heat the shop. I am not a heating expert, but it would seem that I would rather have a more flexible heating system, especially in the summer time.

I may be all wrong in my ideas about this variable drive for I have lived for quite a while close up to the machine shop. Somebody with a broader and more distant and scientific view may be able to analyze it better.

It may be that the idea may be modified so as to be very useful. The amount of slip might be limited so that it would only be enough to take care of the difference in speed that is found between one speed in a gear box and the one next to it. In this way the lost power that would be turned into heat would not be so great, or it might be that this heat could be turned into electricity to furnish light, or it may be that I am wrong about there being any heat or loss of power. If I am I will have to dodge my unmechanical friend for quite a long time, for he has a good memory.

In a paper upon manganese steel presented before the Western Society of Engineers it is pointed out in connection with its magnetic properties that a bar of manganese steel balanced on a knife edge remains in balance when acted upon by the field of a very powerful electromagnet. An electromagnet which would lift two tons of soft steel, when laid upon a block of manganese steel gives so small a pull that the hand recognizes no increased weight in lifting the magnet. A coil passing a current and acting as a solenoid on a bar of manganese steel develops no magnetic quality. Very thin cuttings of manganese steel are not lifted by a strong magnet but if these cuttings are hammered into very thin foil they may then be lifted by the magnet. From these considerations it would appear that this steel might be used to advantage about motors and generators, in a crankshaft, for example.

It is reported by the bureau of manufacturers that many business firms in the United States, when desiring commercial information from any consular district, address their communications to the consul personally instead of addressing the consulate. When letters are addressed to a consul personally they are frequently forwarded to a consul's new address without having been opened, thus causing considerable delay and inconvenience. All communications of an official nature should be addressed simply "American Consul," or "American Consulate," omitting the name of the consul; then the communication will be immediately opened by the official in charge of the consulate.

Gages and Interchangeability in Small Scale Manufacture

By F. A. Halsey

The use of the indicating gage in lever or dial form has found many applications, of which those given in Mr. Colvin's recent article on the "Gages used at the Thomas Automobile Works" are fairly typical. In these applications the instruments are not used as substitutes for snap gages nor in the search for cheapness, as they are, in fact, the reverse of cheap and commonly used in gaging pieces to which such gages are ill-adapted, or do not apply at all.

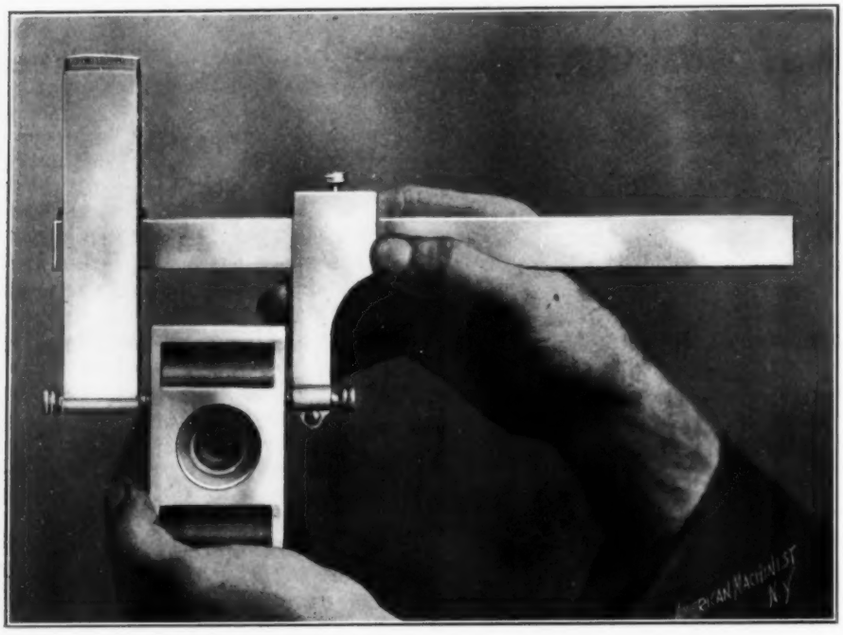


FIG. 1. AN INDICATING BEAM CALIPER

There is, however, a wide range of application of these instruments as substitutes for snap gages and, while they are not individually cheap, the adaptability of a single gage to the gaging of many pieces makes them, considered as an equipment, far cheaper than an outfit of snap gages having the same range could possibly be. In some respects they are, moreover, more satisfactory than snap gages, especially in that different men are more certain to obtain the same results when using them. They cannot be injured by forcing them over a piece which is a little too large, nor can they be made to pass a piece that should be rejected as too large without showing it to be so.

For work of which the size is determined by the workman the snap gage is not popular as a working gage because, unlike the spring caliper, it gives no warning as the correct size is approached and if the limits are small the workman makes several time-consuming small trial cuts for fear that a large one will go below the limit. In this respect the instrument shown does all and more than the spring caliper, as it not only shows but measures the amount remaining to come off.

The usual gaging equipment of a shop consists of two sets of gages, the first being a set of standards, usually in the form of plugs and rings, and the second a set of working or snap gages, one of the uses of the first set being to test and correct the second from time to time. The indicating gage is not, properly speaking, a gage at all, as it is not made to any particular size. It is more properly a size-transfering instrument, with the added feature that after being adjusted to a standard, it gives the amount by which the manufactured parts depart from that standard. The instrument thus takes the place of an entire set of working gages of the more usual form, and as, unlike them, it is adjusted every time it is used, it is not affected by and never needs correction for wear. Since manufacture is essentially the reproduction of standard sizes which are not subject to wear, this instrument, in combination with a set of standards, forms an almost ideal gaging system.

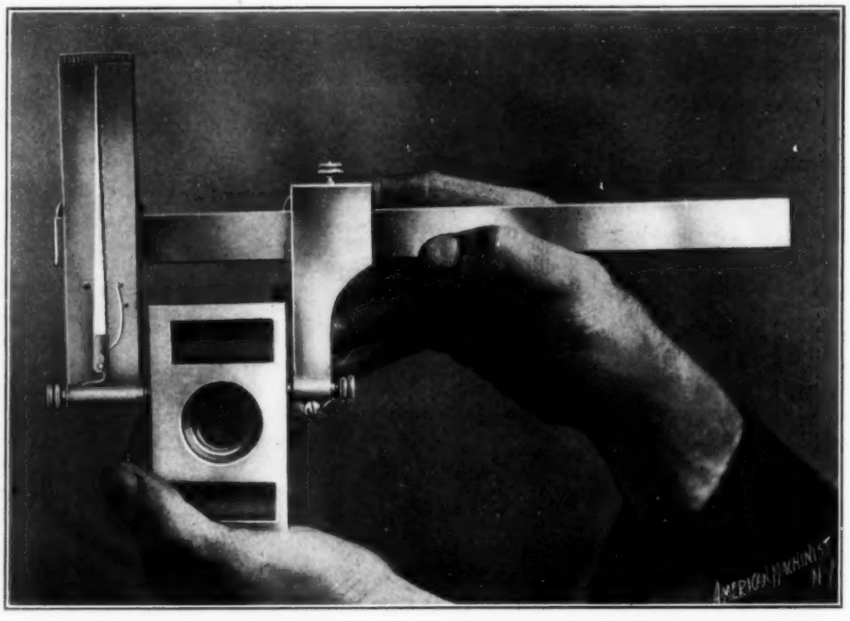


FIG. 2. MECHANISM OF THE INDICATING CALIPER

Interchangeability under Difficult Conditions

Nothing can be more simple or obvious than this use of these instruments, but the fact that they are so little appreciated leads me to believe that an illustration of their use, with results of the most satisfactory kind, will be acceptable to the readers of the American Machinist.

In 1890 I was sent to Canada to establish a branch works of the Rand Drill Company for the production of rock drills. The rock drill is a machine in the production of which interchangeability is of more than ordinary importance, the severe work and usage of the machines leading to a trade in repair parts which is far beyond that of most branches of machine manufacture. That these parts shall fit is of paramount importance if the customer is to be a satisfied customer, and we have thus a condition which, in addition to those that usually prevail, demands interchangeability to a degree not found in most lines of work.

The expectation was that at the start the business would be small and in this

we were not disappointed as also we were not disappointed in believing that ultimately it would grow to large dimensions. Under the conditions which prevailed at the start cheapness in the shop equipment was imperative, while the necessity for interchangeability was not lessened by the small, initial volume of business. At the same time an equipment which would have been more than justified on the American side of the boundary line was entirely inadmissible under the actual conditions, the problem that confronted us being the establishment of interchangeability without swamping the company in manufacturing and gaging equipment.

Under these circumstances I fell back on the indicating beam caliper shown in the illustrations and the results were all that could have been asked, our work being interchangeable from the start and, as a matter of fact, far superior in that respect to the product that was then being turned out by the home shop. The illustrations show the instrument 'after 19 years of use. In Fig. 2 a protecting shield has been removed in order to show the mechanism of the pointer.

The Instrument and Its Use

The instrument, which was made by the Syracuse Twist Drill Company, scarcely needs description, being nothing more than a beam caliper with a multiplying lever in the left-hand head and a scale at the top, which reads to thousandths of an inch. The zero of the scale is at the center, and the range is such that 0.016, plus or minus, may be read. The beam is not graduated, nor are means of any kind provided for setting the instrument to definite sizes, this being done by applying it to a standard gage, the final adjustment being obtained by the nurled head in the right-hand head, by which the pointer is quickly brought to zero when applied to the standard gage, as shown in the illustration. In gaging parts as manufactured, it is only necessary to apply the instrument in the manner shown in the illustration, when the error in the work, plus or minus, is at once read off from the scale—any given piece of work being kept within any limits desired by tabulating these limits for the use of the inspector.

In the case referred to, the standard gages would have been looked upon as very primitive by many, being nothing more than the parts of a stock machine sent from the American shop for that purpose. This machine was dismantled, the parts being stored away, and kept for no purpose except that of reference gages. A nice, shiny set of plug and ring gages on the tool-room shelves around have appealed to one's mechanical pride, and in some cases would have been more convenient, but I doubt if the results would have been better.

Of course, there are parts and dimensions of parts to which this form of gage will not apply; but that is equally true of snap gages. So far as gaging simple male pieces are concerned this plan is practically universal, and of female pieces it will, by turning the heads around on the bar, apply to anything made on the planer or milling machine, provided, that is, the part to be gaged is large enough to span the heads when so reversed.

Advantages of the System

Among the advantages of this system of gaging is the fact that the limits may be changed as experience accumulates and shows that to be necessary or desirable. The fixing of limits by a set of snap gages is a serious matter. When later experience shows it to be necessary to use finer limits on some parts and feasible to use coarser ones on others, the change involves discarding the gages and making new ones if snap gages are used, whereas under the plan shown, such a change involves nothing but erasing the old and writing the new limits in the list.

Other Uses

Not only may the instrument be used for repeating standard sizes, exactly or within limits, but it may also be used for making parts of sizes having determined small differences from standard dimensions; that is, for turning shafts with allowances for press, shrink, or running fits, the range of its scale being sufficient for such work within its capacity. For this work nothing more than a set of comparatively inexpensive reference disks is necessary, and such an outfit, with the instrument described in such numbers as are needed, supplies a shop with an equipment for doing standard and interchangeable work that is by no means to be despised.

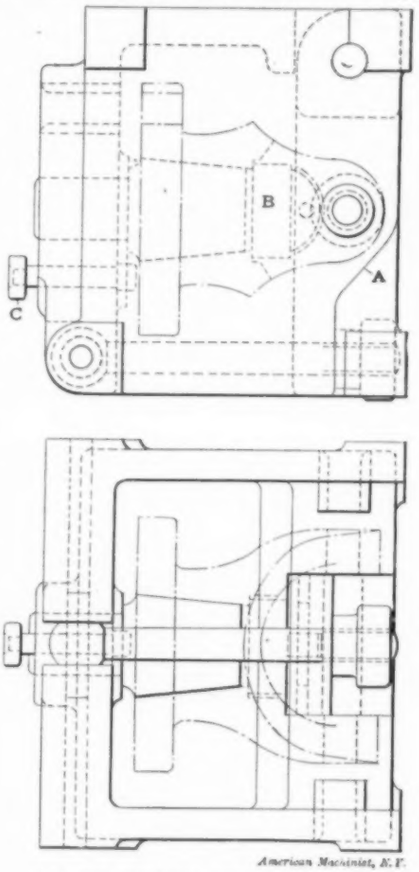
The reader will, no doubt, compare the instrument with the micrometer caliper, saying that that instrument will do all that this will do, in which he is, of course, correct. The real comparison between this instrument and micrometers is, however, substantially the same as that between it and snap gages, in that it is required in fewer numbers and is independent of wear and of personal differences in making measurements. When doing interchangeable work there is, moreover, no system so satisfactory as that which habitually goes back to reference standards, and this the system described does, while the use of micrometers does not. The more the system is studied, the more I believe it will be admired, the only reason for its neglect that I can imagine being that in its obvious simplicity it has been overlooked, for it is a curious feature of all mechanical development that in the search for results the simplest means often come last.

I never see an expensive collection of snap gages without asking myself if the purchaser knew, or knowing, reflected upon, the possibilities of this simple instrument as a substitute for the entire collection. While snap gages have their use, and large use, it is nevertheless true that many spend more money on them than there is any necessity for doing, and that others are deterred from introducing the limit system of manufacture because of the mistaken idea that it involves the expenditure of a lot of money for snap gages. If only as a means of demonstrating the advantage of the limit system and of leading to snap gages in the end, or of introducing the limit system at an early stage of manufacture when it cannot otherwise be seriously contemplated, this instrument deserves a thousand times the attention it has ever received.

A Jig for Drilling Knuckle Joints

By Walter C. Frank

The cut shows a jig for drilling knuckle joints which is used by a prominent manufacturer of milling machines. This jig



JIG FOR DRILLING KNUCKLE JOINTS

differs from the ones previously described in your paper. In this case we have a taper hole, to locate from, which is reamed to the proper depth, after which the fork is milled.

This jig consists of a cast-iron body, a taper stud and the swinging piece *A*, which fits the fork, assuring the holes coming square with the milled surface.

This swinging piece also acts as a clamp holding the work on the taper stud. *B* is a shoe which is hinged on the part *A* so as to accommodate itself to the work, should there be any slight variation in machining. *C* is an ejector.

Building the Stanley Steamer

A Water Glass Open at the top on a Boiler Carrying 500 Pounds of Steam. Ball Bearing Crosshead, and Some Other Interesting Details

EDITORIAL CORRESPONDENCE

Here is one case at least where the old saying about the prophet being without honor in his own country seems to have slipped a cog, for of all the 7000 or thereabouts Stanley steam automobiles that have been built nearly every one has been sold within 50 miles of the factory at Newton, Mass. Those who remember the early stages of the automobile will recall the multitude of little steam cars that were made and sold under the name of Locomobile and Mobile, and it is interesting to note that both of these were built under the patents of the Stanley Brothers, who have kept right on along the same line, while both the others have long been ancient history.

Making the Boiler

While many of the details have been improved, the engine placed horizontal so as to gear direct on the axle without the use of a chain, the boiler placed in front, etc., and the general principles remain the same. Beginning with the boiler, which is of the fire-tube type, very similar to those used in steam fire engines, we find a steel drawn shell, without a seam and with one head drawn in place. The other head is slipped in and the shell beaded over. Both heads are drilled and tapped so that when the tubes are expanded into them it forces the metal into the threads in the tube sheet and adds to the resistance against bulging. This is especially desirable when it is remembered that these little boilers carry 500 pounds steam pressure. The tubes are expanded as usual and each end of the boiler has a steel ring shrunk onto it as can be seen in Fig. 1, where the final touch is being given in the shape of the outer winding of the best quality of piano wire. Four separate windings are made and each wire fastened independently so as to secure the maximum strength and prevent any possibility of accident from explosion. This view shows how the boiler is mounted in a large lathe and how the wire is fed on to lay evenly by using the carriage feed. The wire goes from the reel to the small guide wheel, then over the larger pulley above, making several turns around this to secure tension enough to be controlled by the brake at the other end of this same shaft, and then to the boiler. In this way a very nice job is made in a minimum of time.

An excellent example of gang slitting is shown in Fig. 2 where the burner that goes under the boiler is being cut. The vaporized gasolene comes in under this after passing over the top of the boiler, as shown in Fig. 4, through the coil of pipe, then down to three pipes running directly through the fire and out through jets under the burner plate shown. This makes a fire like a young blast furnace

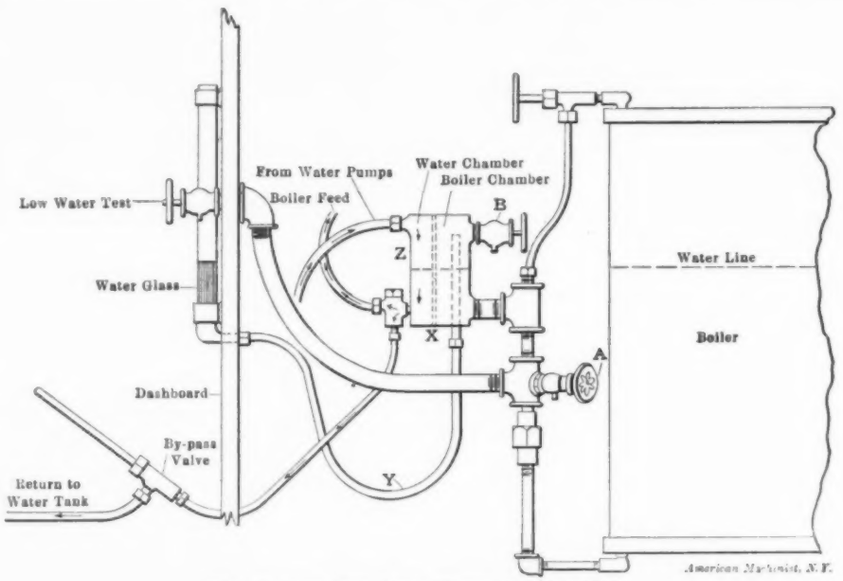


FIG. 3. HOW THE OPEN WATER GLASS WORKS

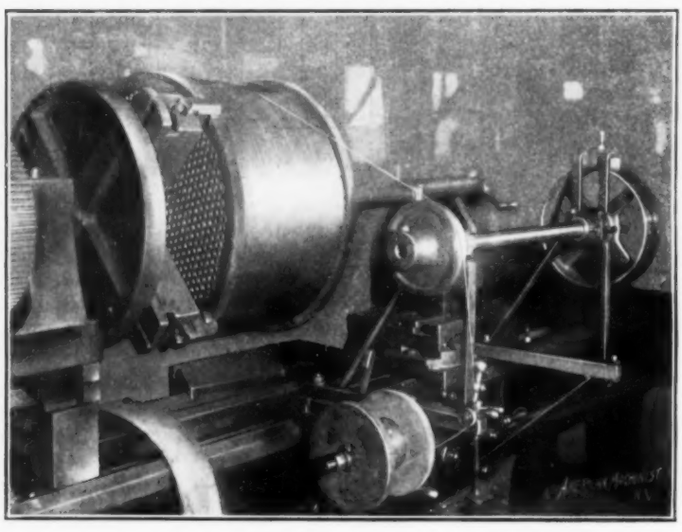


FIG. 1. WINDING BOILER WITH PIANO WIRE

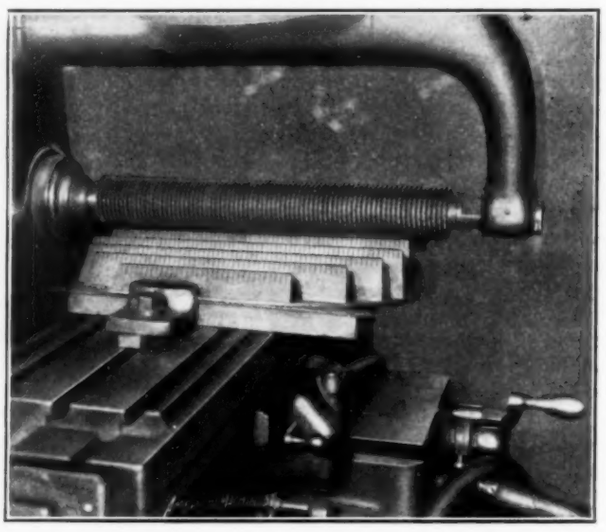


FIG. 2. SLITTING THE BURNER

and the way it gets up steam is a surprise to those who are not familiar with gasolene as a fuel.

An Open-top Water Glass

One of the most original features about this car is the water glass shown in detail in Fig. 3, which is in front of the dashboard in front of the driver. The annoyance and possible danger of having a water glass break with 500 pounds of steam in the boiler led to the designing of an indicator in which the water glass is open at the top, which means that it has no direct connection with the boiler, yet indicates perfectly the hight of water in it. There is a connection top and bottom of the boiler with the try cock *A* and connecting to the boiler chamber *X*, so that the water stands the same hight in this chamber that it does in the boiler, just as though this were a gage glass instead of being made of steel. A portion of this is partitioned off at *Z* and through this the water from the feed pump goes on its way to the boiler to help cool this chamber and make the indicating tube *Y* more sensitive. This tube is filled with water to the top of its inner end and closed tightly at that end, the water then standing at a corresponding level in the glass on the other side of the dashboard. The steam in the boiler chamber above the water line vaporizes the water in the indicating tube *Y* and drives the water up in the glass to the hight shown. If the water in the boiler lowers, there is more steam in the boiler chamber and the water is forced higher in the glass, which it will be seen, indicates in a reverse manner but indicates very accurately according to those who have used it. This is also shown in Fig. 4, which also shows the location of the boiler and the water and gasolene piping in connection with it.

Planing the Valve Seat

The two cylinders are cast together with a common steam chest between them and plain slide valves for each cylinder. This makes rather an awkward place to machine, but the fixture shown in Fig. 5 makes it easy to do on a shaper. The cylinders are held on the fixture, being located by the bore and the extension planer tool enables the valve seat to be planed without difficulty.

It will be noted that the steam-chest cover is round and it is interesting to note that both this and cylinder heads are all screwed into place instead of being bolted in the conventional way. The threads make a fairly good fit, but the real joint is made by a gasket in a bevel next to the thread. A liberal application of oil and graphite on the thread is said to prevent any tendency toward rusting fast or making it difficult to remove the heads after being in use.

Fig. 6 gives a fair idea of the engine itself as well as the way in which it is connected up to the carriage. It lies nearly horizontal and gears direct with the differential or jack-in-the-box on the rear axle. Drop forgings are used throughout, the connecting rod being of a forked construction so as to reach around the crosshead and make the wrist bearing. The ends are spread apart and coned with a hollow mill to fit the cone bearing in the crosshead, and with this exception all the other bearings on the engines are of balls, even the crosshead, as can be seen. The main bearings have ¾-inch balls while the rest use ½-inch balls, and there seems to be a lack of trouble in the bearings that is not always found in other styles, in spite of the fact that balls are not in general favor in such places.

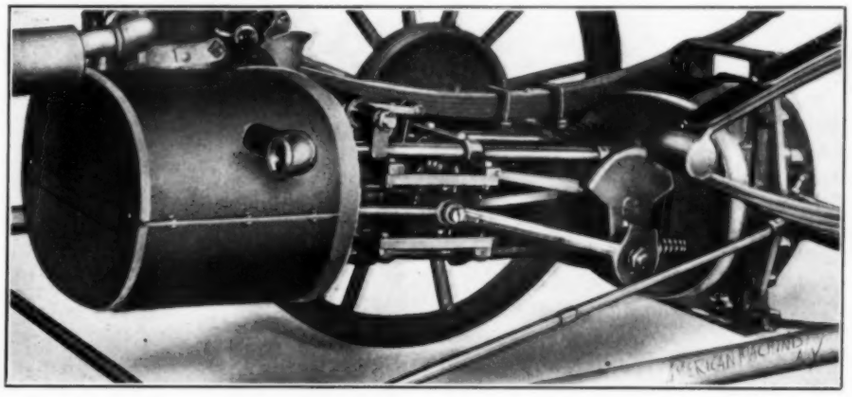


FIG. 6. THE ENGINE AND ITS CONNECTIONS

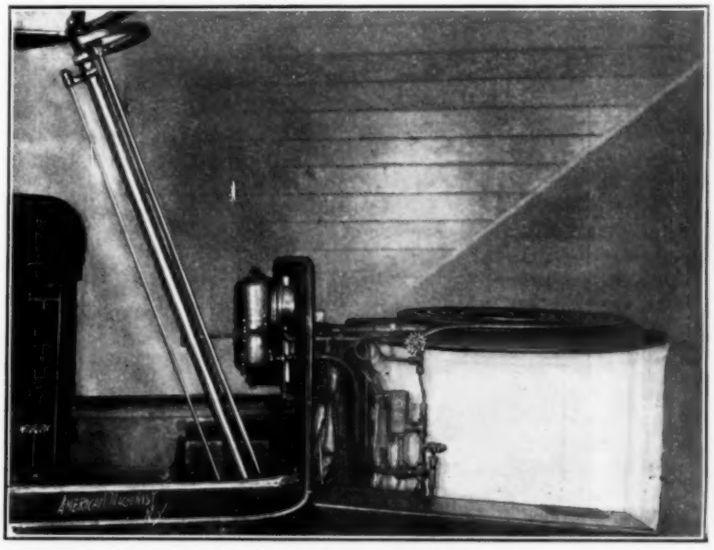


FIG. 4. THE BOILER AND ITS CONNECTION

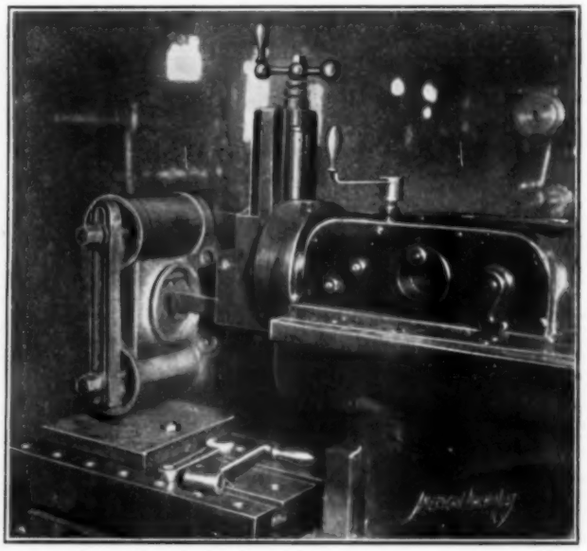


FIG. 5. PLANING THE VALVE SEATS

A Ball-bearing Crosshead

The crosshead bearing consists of two ½-inch balls, one on each side, as can be seen by a careful examination of the engine. This strikes one as peculiar until we stop to think that they must always be opposite, and that the pressure is never on both sides at once, but always alternating from one guide to the other. There is

a stop pin at each end of the guides to prevent the balls getting out of place and these also keep the two balls exactly opposite each other at all times. As a test of this Mr. Stanley had an engine on the test rack stopped and one ball pushed to one end of its travel and the other to the opposite end. On starting the engine again it took only a half revolution to bring them both into their proper relation and there they stay as they run back and forth at any speed up to 300 or more turns a minute.

The valve gear is the plain link which has withstood the shock of so many improvements, and is still the acknowledged leader for simplicity and effective steam distribution under the conditions which present themselves to a locomotive or a road carriage. But one cutoff is provided, that at one-quarter stroke, which is plenty good enough for almost any running and avoids complication and confusion to the average operator. The quadrant, or what serves for one, is shown right over the front cylinder head in Fig. 6.

Two Grinding Fixtures

The links are ground on a very ingenious fixture, as shown in Fig. 7, rigged up with a head from a Rivett grinder. The links are held on the plate shown which is hinged from a point at the back so as to secure a correct radius for the links and the movement past the grinding wheel is secured by the heart cam behind the holding plate. A roller on the back of the plate runs on the edge of the cam and the motion of the work past the grinding wheel is easily accomplished, the spring keeping the roll in contact with the cam.

Another grinding job is shown in Fig. 8, where ball races for the eccentrics are being ground on a regular machine of the same make. The swinging chuck gives the desired shape to the ball race and the size is measured by the gage shown on the bench. This is a special pair of inside calipers with ½-inch balls on the measuring point and the other ends forming a positive stop by being brought together. They open like any calipers and are introduced into the ball race and the outer ends closed. If they just meet and there is no shake in the race, the size is right, and variation is easily detected and the use of balls of the size that are to run in the bearing makes it a practical test in every way.

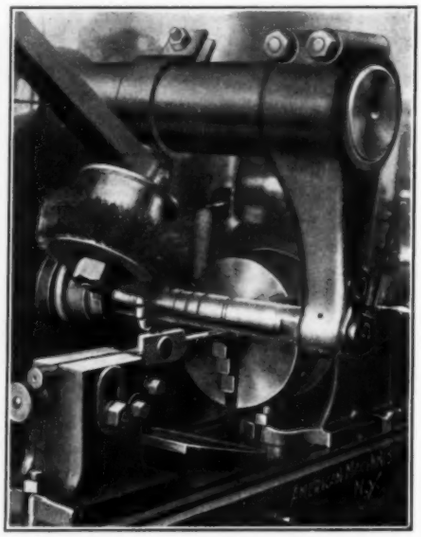


FIG. 9. KEEPING THE MILLING CUTTER CLEAN

In such milling work as the crossheads where it is very desirable to have a smooth job, it has been found advantageous to keep the milling cutter clear from chips, and to do this without taking the operator's time the device shown in Fig. 9 was rigged up by an ingenious mechanic. The pulley carrying the brush is mounted on a spindle which is held to the overarm of the milling machine by a band going around the arm and allowing it to be held at any angle to accommodate different sizes of cutters.

We are indebted to the courtesy of both the Stanley brothers for the assistance in securing these illustrations and the information concerning their product.

F. H. C.

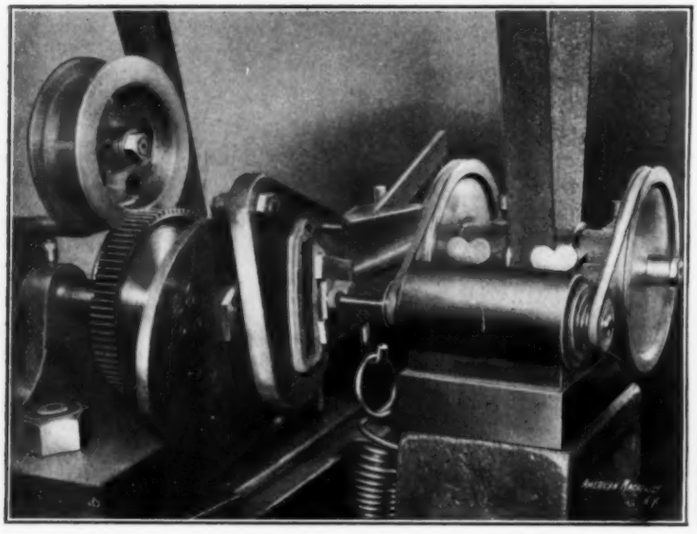


FIG. 7. GRINDING THE LINKS

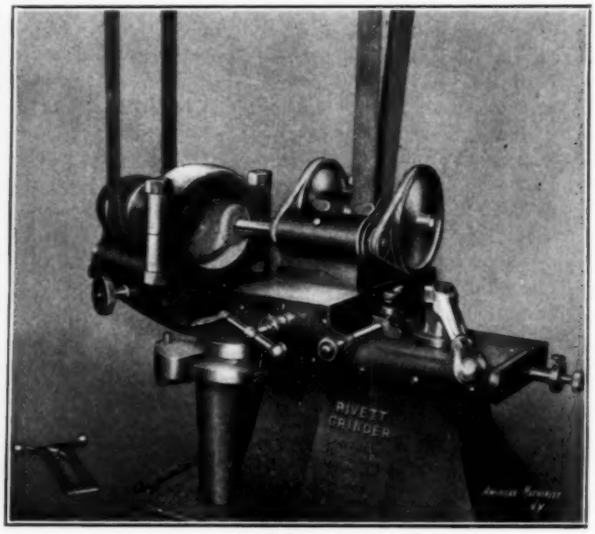


FIG. 8. BALL RACE GRINDER AND GAGE

"Peter the Great of Russia, Mechanic"

By C. J. Smith

We think of this great man as the regenerator of Russia; the mighty and solitary lever which in 36 years raised Russia from a semi-civilized kingdom to the level of other European governments. With him we associate the building of St. Petersburg; the sweeping away of barbaric Asiatic customs in favor of the modern manners of Europe; mighty wars with Sweden, and with other States which are now part and parcel of the great Russian empire, but we hardly remember him as the humble workman passionately fond of making horseshoes and boots, constructing boats and working at the forge

Had Peter not been a ruler he would have made a very good workman; in fact, he probably would have excelled at anything—except learning—knowing, as we do, that his was a character possessing many phases. With him the greatest and most ludicrous were mingled together; benevolence and humanity were as conspicuous in him as his total disregard of human life; he was at once kind-hearted and severe to ferocity. Without education himself, he promoted the arts and sciences. As Voltaire says: ". . . he gave a polish to his people, and was himself a savage; he taught them the arts of war, of which he himself was ignorant; from the sight of a small boat on the river Moskwa, he

created a powerful fleet, and made himself an active and expert shipwright, sailor, pilot and commander; he changed the manners, customs and laws of his people, and lives in their memory as the 'father of his country.'"

Although Peter took a great interest in arts and crafts, there is no reason to suppose that had he been anything but a ruler he would have remained a commonplace workman. As an ordinary workman he would have been a failure, for he was too fond of dropping a subject as soon as he knew all about it, an assertion that receives support by the number of incomplete pieces of work performed by him, and now exhibited in various places in St. Petersburg and Moscow. We have asserted in our second paragraph that Peter would have excelled at anything except learning; so he would have done, and in the case of the workman he would have excelled only as a man possessing a variety of ideas which would never take the finished form under his own hands.

We must not assume that if Peter had been born in an humble station he would have remained there. Nature intended him for a ruler of a badly governed country, and in spite of birth, he would have risen to great hights. He had a mind that would not allow great things to pass him by for the sake of gratifying his passion for mechanics; if he built a boat he was not only following a hobby, but he had in his mind the prospective value of that boat as a unit in the construction of his empire.

History also raises the suspicion that Peter's wish to learn everything was prompted by the desire to be in a position to teach and encourage others. That he did encourage others is common knowledge, and this encouragement did much in pushing Russia to the front rank of nations.

We know that Peter reigned but 36 years, so that we can see at a glance how energetically he worked in the cause of his country. At the age of 19 he commenced the reformation of his country, and from that time we see again and again evidence of the fertility of the great man's brain, and the presence of the methodical nature generally attributed to the good workman. At one and the same time he commenced the reformation of his country, thought of a grand army, and the construction of a model boat. He sent the people of his court abroad to learn good manners, and become polished in every way, and at the same time busied himself forging bars of iron in the smithy and proudly putting his name thereon. He could make plans to suppress an uprising against him, and yet find time to make boots and claim his salary as an ordinary shoemaker!

Peter's most important step was the formation of an army, a necessary detail, considering the lawless state of the country, and the hostility of the neighboring states. He engaged two foreigners, viz., Patrick Gordon, a Scotsman, and Lefort, a Swiss. During the organization of the army, we discover the craze which Peter had for learning the ins and outs and whys and wherefores of everything, for history tells us that he was content to leave the organizing work to his generals, Gordon and Lefort (Gordon was the greater man) while he entered the army as an ordinary, common soldier with the determination of working his way upward. He also forced the young noblemen to follow his example, a step which caused a great deal of trouble.

Having raised the skeleton of a good army, and satisfied himself that it could be well looked after by Gordon and Lefort, Peter gleefully commenced the realization of his great and ever present dream, that is, the construction of a boat that was to please his own fancy and at the same time form the nucleus of a navy. Those who have studied the history of Peter to any extent question the wisdom of his building boats when he could have ordered as many as he liked from abroad, but in this direction the mechanic overshadowed the Czar; the mechanic wanted to know, and personally superintend, every detail of construction, and this would be impossible in the case of ready-made ships from abroad. As we have said, the practical man wanted homemade ships, but the practical man, good mechanic though he was, knew that he required expert assistance, and with the object of obtaining same, he hired a number of Dutch and Venetian shipbuilders, and soon had the satisfaction of seeing some small vessels on lake Peipus, and a flotilla on the Don. Peter was proud of these vessels, for he had his say in respect to the most minute detail of each boat.

The lake and the river, however, did not afford Peter much scope, and besides, his dream was one where sea-going ships predominated. Here again Peter would not have ships the construction and management of which were, so to say, a sealed book to him. Consequently he journeyed to Archangel, where he worked as an ordinary seaman on various British vessels. The life which he led as a common seaman developed his passion for the sea, and at the same time greatly strengthened his idea of the necessity for a powerful fleet. He therefore despatched a number of young Russians to Holland, Venice and Leghorn to learn the whole business.

Most rulers would have considered this enough to encourage the people to go in for shipbuilding, but Peter did not, for he knew too well the character of his subjects, and the innumerable details connected with the work. Therefore, having settled many questions of importance in connection with the administration of his country, Peter went to Holland in 1697. He settled at Saardam, hired a small lodging with two rooms and a garret and a shed adjoining. He purchased carpenters' tools, donned the dress of the trade and spent most of his time in working as a common shipwright. He called himself Pieter Timmerman, and lived and worked as an ordinary Dutchman, even going to the extent of cooking his own food. He went extensively in for shipmaking, ropemaking and smiths' work. With his own hands he made from beginning to end a bowsprit for his own yacht. He even insisted upon receiving from an expert Dutch shipwright a certificate testifying to his capabilities.

During his residence in Holland a visit to the dentist suggested to Peter the idea of learning the business, and thus we find him at odd intervals pulling the teeth of suffering patients. It is said that Peter expressed his indignation because none of his subjects developed toothache, in order to allow him to operate on them. As toothache is one of the most common ailments in Russia, we have reason to believe that Peter's subjects suffered in silence when in his presence.

There is no actual record of the work accomplished by Peter during his short stay in Holland, but it was considerable, judging by the many exhibits in the Hermitage in St. Petersburg.

In 1698 Peter proceeded to England, with the object of learning the theory of shipbuilding, and the making of drafts and laying them off in the mold-lofts. He stayed at Saye's court, Deptford, near London. He also spent a great deal of his time at Rotherithe, where a ship was being built for him. It was characteristic of Peter to make innumerable suggestions, many of which, it is fair to state, were adopted by the builders.

Peter's taste for mechanics led him into bad odor with the owner of Saye's court, a certain influential man by the name of John Evelyn. First, Peter took a very great interest in the locks and hinges of the doors, and consequently found it necessary to pick the former and take off the latter. Second, he had a peculiar taste for being pushed about in a wheelbarrow, and especially through a wonderful hedge in the garden attached to the house. Peter being a man close upon 7 feet in hight, we can guess that a pretty big hole was made in the hedge. It might be interesting to note that Peter did so much damage to the house that the owner applied to Parliament for compensation.

While in England, Peter was essentially the workman, so much so that he refused to be publicly feted, but during his hours of rest adjourned with his companions to a public house on Tower hill, where they smoked and drank peppered brandy.

After feeling that he had learned enough in England, Peter returned to Russia, taking with him a number of Englishmen. Immediately on his arrival home he put into practice all the schemes which had matured during his residence in England and Holland.

The above gives one an idea of what

Peter did in order to become acquainted with various handicrafts. It must not be understood, however, that on his return to Russia, and during the working of the many gigantic schemes for the betterment of his country, he gave up his various hobbies. The many exhibits in the Hermitage, the Academy of Sciences, and the small wooden house erected during the building of St. Petersburg testify to the unabating interest which he continued to take in all mechanical subjects.

The Hermitage possesses a rich collection of tools, comprising numberless chisels, augers, braces and bits, planes, hammers, in fact, the entire outfit necessary for an uptodate carpenter. The majority of these tools bear evidence of being well used. In addition, there are three wood-carving machines, ordinary lathes and circular saws. The lathes are of the ordinary old-fashioned type, and consequently do not need describing. With reference to the wood-carving machines, a brief description might not be amiss. At one end of the machine there is a drum, over which is placed a copper or brass cylinder whereon there are various patterns in relief. At the other end of the machine is a spindle on which is attached a cylindrical block of wood, of a size smaller than the metal pattern at the other end. The block spindle is connected by means of a crank to the drum bearing the pattern, and both are made to revolve by means of a hand-driving wheel. By means of a further mechanism, which is missing in the case of each machine, the pointer which travels over the face of the pattern forces a cutting arrangement to execute similar movements on the face of the wooden cylindrical block. Unfortunately, there are very few specimens of the work accomplished by Peter by the aid of these machines, consequently we are unable to judge of the excellence of his work. As to the few specimens exhibited, they are in the incomplete stage, but are promising.

In a cabinet there are one or two specimens of carved ivory executed by Peter, but whether the work was done by hand or machinery we are unable to ascertain. In either case, for a novice, the work is good.

In the Academy of Sciences there is a bar of iron which Peter forged at Olonetz. If it is not quite accurate, it is a specimen of good work. In the small wooden house opposite the fortress of St. Peter and Paul, which was built during the construction of St. Petersburg, is a boat which Peter made during the building operations. We are unable to describe this boat as, for the sake of preservation, it is covered with canvas.

There is one exhibit in the Hermitage that strikes us as being peculiar, and out of place when associated with Peter, and that is a part of a tree stump used in flattening the earth. Peter cut the tree himself, and formed it in such a manner that it should possess three wooden handles, which are part of the tree itself. We have the feeling that Peter, with his ingenuity, would have invented something more practical, or, at least, imported something more uptodate. Upon reflection, however, we observe the great characteristic of Peter; that is, his total disregard of everything that did not interest him from the mechanical or empire-building point of view. This earth-beater did not call for special attention in the way of improvement, and as Peter had others to flatten the earth, he did not give a second thought to the article.

Departing from the subject, it might be interesting to know that an exactly similar instrument is used for the same purpose up to this very day in St. Petersburg.

By the presence of a number of walking-sticks, one containing a watch, and others, respectively, a compass and a measuring rod, we see that Peter was either a faddist, or a man prepared for any emergenncy. In any case, we have another illustration of details of minor importance escaping his attention, ingenious though he was, for had he given his walking-sticks a second thought we may be sure that he would have made a stick capable of carrying the watch, compass and measuring rod all together.

By the presence of a number of technical books, it is seen that Peter was a believer in theory as well as practice. By the absence of educational and scientific works, we can assume, by the same method of deduction, that Peter personally did not care a rap for such subjects.

Summing up the character of Peter, it is evident that he was a man possessing many excellent mechanical ideas, but at the same time was not blessed with the faculty of finishing everything that he commenced. Perhaps the cares of state prevented the completion of many of his undertakings of this nature, although this is hard to believe, seeing that he could always find time for something else, no matter how busy he may have been in connection with the government of his country.

By reading the history of the building of St. Petersburg, it is seen that he was a good organizer, and, therefore, in humbler circumstances, would have made a very good foreman, but very unorthodox and extravagant. He was a good organizer because be brought to St. Petersburg thousands upon thousands of men to build the city, and although the country was a barren waste, and, therefore, unproductive, Peter kept those men at work and supplied them with foods in the face of insurmountable obstacles. He was unorthodox because he built his city in flat contradiction to all the laws of engineering and architecture. Extravagant because he impoverished other towns in order to find the wherewithal to build this great city which bears his name.

We now come to the question of the effects of Peter's love for mechanics upon the nation. Unfortunately, he did not live long enough to put the finishing touches, as it were, to his good schemes. Peter made the great mistake of assuming that the people would become possessed of the same enthusiasm as himself, and in consequence went only so far in his work, instead of completing everything to the merest detail. Had he perfected each idea, and put it on a properly established and workable footing, the industrial history of Russia might have been different. For instance, had Peter been more exacting in his demands in respect to shipbuilding, it is possible that Russia of today would have owned the finest fleet in Europe, and manufactured the best of iron, and (in view of the vast mineral deposits) in such a quantity as would have driven other nations out of the market.

It was only his intimate associates who became imbued with Peter's enthusiasm, as, for instance, men like Menshikovy, who went with Peter to England and Holland, and afterward built his own chapel.

However, Peter's memory lives green in the memory of the people of today in Russia, and they point with pride to the many little objects which are associated with him as the mechanic, so we must assume that the imperial workman has affected the people, if only from the sentimental point of view. Perhaps when the people think less of him as the "father of his country," and more of him as "Peter Timmerman, the boat-builder and mechanic," we shall see the good fruits of his encouraging efforts.

St. Petersburg, Russia.

Transparency, when mentioned in connection with metals, is, no doubt, a surprise to most people, but from some extremely interesting experiments conducted by Professor Turner at the University of Birmingham, it is to be noted that some new observations have come to light pertaining to this subject. No matter how finely rolled or hammered the only metal heretofore associated with transparency has been gold, but from the investigation followed by Professor Turner it has been discovered that silver and copper also possess this quality when subjected to the proper treatment. In the case of silver it was found that when heated to about 390 degrees Centigrade and rolled very thin, glass plates over which it was spread were practically unaffected so far as transparency was concerned. In the case of copper it was shown that thin sheets of it heated to the proper temperature in the air became practically transparent. While the observations are of no known practical utility they have attracted considerable attention in scientific and artistic circles, as the color effects transmitted by the metals under such conditions are said to be of striking interest.

A Cost System That Controls Costs

If the Time of Production Tends to Exceed the Estimate It Is Discovered and Reduced. Costs on Closed or Open Orders Can Be Had Instantly

BY HERBERT M. RICH

Six or seven years ago a systematic keeping of costs was commenced by the Cleveland Automatic Machine Company, with a determination to accomplish certain greatly to be desired results in cost accounting. Before entering into its detailed description, it is not amiss to give a general outline of the theories around which it has been built up, as therein lie the essential points of difference between this system and the majority of existing cost systems. An appreciation of these ideas will give the reader a clearer conception of the methods and results.

Fundamental Principles

The first vital theory is this: to be of the greatest value, costs of any, or all, material under construction should be available immediately. If three or four days, a week or a month, are required to compile completed costs, the utmost advantage of those costs is lost. The Cleveland Automatic Machine Company can tell the accurate cost of any piece under construction, at any time, on a moment's notice. Costs obtained after an article is complete, while valuable for reference, are necessarily records of things that are past and gone. You cannot turn the mill wheel with water that has passed; neither can you correct an excessive labor cost by records after the operation is completed. Here lies the second cardinal principle in this system. Use the water while it is here; that is, instead of using hindsight use foresight, and exercise, through an efficient cost system, control of manufacturing operations and point out immediately the first signs of prolonged time on any job before the operation has progressed very far and thus save time on the balance of the operation.

A dollar in material or labor is of equal importance to a dollar in the cash drawer, or as an open account in the sales ledger; yet, how infrequently is this fact realized by the average shop foreman or employee and even by executive heads! Many such men will enter into a lengthy correspondence over a disputed small account of a dollar or two, but are daily tolerating wastes of this class, amounting to 10 or 20 times the amount of the trifling account, not considering it of enough importance to follow up and, thus, are sustaining losses through the left hand in the factory, which far outweigh the gains made with the right hand in cleverness in supervision of the office end alone. Often this is the determining factor between success and failure. To eliminate these losses and to so supervise actual construction as to point out to the executive heads cases that need investigation, while in actual operation, very properly comes within the scope of an efficient cost system. It provides an able assistant to the factory management by apprising it in time to stop leaks that would otherwise prove expensive and would not have been discovered until too late.

Another point of difference is in the collection of time data from the factory. Contrary to the usual custom the workmen do not furnish the time cards. A careful consideration of this led to the conclusion that costs based on such data were unreliable in that the average shop man's only concern is that he report for enough total time to cover a full day; whether a certain job is charged with one or three hours does not concern him as long as he is not detected, and it gives the temptation to a man to doctor his time card to average up jobs, taking off of long operations and adding on to something that he thinks will stand it. Given these as basic data, the completed costs are inevitably unreliable.

Origination of Orders

The general storeskeeper's record, Fig. 1, shows all receipts of material and deliveries and balance on hand, together with quantities on order. All orders for stock parts originate with the storeskeeper.

OPERATIONS	TIME ESTIMATE 1st Oper.	2nd Oper.	3rd Oper.	4th Oper.	Complete
First Floor Lathe					
Second Floor Lathe					
Globolt Dept. X	20	30			50
First Floor Vise					
Second Floor Vise					
Third Floor Vise					
Feed Bracket Dept.					
Spindle Head Dept.					
Drill Press X	6				6
Laying Out					
Planer					
Milling Dept. X	45				45
Grinding Dept.					
Polishing Dept. X	4				4
Forge Dept.					
Experimental Dept.					
Tool Room					
Boring					
Power Press					
Hand Machine					
Belt Cutter					
FSX					105
Casting Stores X					
Pattern Shop X					
Testing Dept.					

Return to Cost Dept. when your operation is finished.

STOCK ORDER — ORDER NO. 16943

Foreman MILLING DEPT. Date 3/11/09

Operation No.	Operator No.	Name	Date Begun	Hour	Date Finished	Hour
1						
2						
3						
4						

Quantity	Piece No.	Mach. Size	Style	NAME OF PIECE
75	76	2-3/4	NM	Gear.

Above Stock to apply on M. O. No. 674

Drawing No. 6032

American Machinist, N.Y.

FIG. 2. FORM OF STOCK ORDER

PIECE NO. 113 SIZE 1¼ MAX. 50 STYLE T MIN. 25 NAME Bell Crank

STOCK ROOMS: A SECOND FLOOR, B ANNEX, C TOOL ROOM — CK. ✓ — LOCATION: SHELF NO., BIN NO. 940, FLOOR NO.

DATE	ORDER NO.	QUANTITY ORDER'D	RECD.	DELD.	ON HAND	APPLYING ON ORDER NO.
3 10	1040	50				
" 16	"		50		50	
4 2				10	40	mc640
5 10				5	35	m6844
" 16				14	21	" 7761
6 4				8	13	mc675
" 9				1	12	m7641
" 10	1675	50				
" 17				4	8	m7330
" 24	1675		25		33	
7 8				6	27	m7461
" 19				24	3	mc741
8 2	1675		25		28	

DATE	ORDER NO.	QUANTITY ORDER'D	RECD.	DELD.	ON HAND	APPLYING ON ORDER NO.

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FIG. 1. STOCKKEEPER'S RECORD CARD FORM

*Office manager, Cleveland Automatic Machine Company.

In building a quantity of machines, (as example, twenty-five 4¼-inch turrets) a machine construction (MC) order is issued by the superintendent to the storekeeper and assembling foremen. The storeskeeper then issues "requisition for order," one order for each piece, that is, if a completed machine had 300 pieces (exclusive of small screws, etc.) he would issue 300 orders, basing quantities on the balance shown on stock-record cards. They are then sent to the estimating department.

PIECE NO. 76 — OPERATION MILLING — ORDER NO. 16943

SIZE OF MACH. 2¾ TUR. STYLE NEW MODEL — NAME Gear — QUANTITY 75

TIME EACH			DAILY OUTPUT						Oper.	WORKMAN	KEY	STARTED		TIME RECORD						TOTAL	RATE	AMOUNT
Oper.	Est.	Act.	Mon.	Tue.	Wed.	Thur.	Fri.	Sat.	No.	NAME	No.	Date	Hour	Mon.	Tue.	Wed.	Thur.	Fri.	Sat.	Hours		
1	45	46½				6	13	6	1	H Jones	337	3/11	9	9	4½		6½	10	5			
2			13	13	14	10								10	10	10	7			58½	22½	13 10
3																						
4																						
5																						
6																						
Comp																						

MEMO FOR SUSPENSIONS IN OPERATION

1		2		3		4				OPER.		DATE	OPER.	6		7		8		9		10	
Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start	No.			No.	Stop	Start	Stop	Start	Stop	Start	Stop	Start	Stop	Start
											Monday												
											Tuesday												
											Wednesday												
2·00	2·30										Thursday												
											Friday												
											Saturday												

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FIG. 3. FORM OF OPERATION CARD USED AT TELEPHONE DESK

With the feeds and speeds of machines performing the operations known, and taking into account the amount of stock to be removed, the length of travel and character of stock, the time required for each operation is estimated by the slide rule. The different operations are subdivided as for lathe work, roughing cut, finishing cut, etc., and due allowances made for setting up. These time allowances are then entered on the reverse side of form of requisition for order for all operations required to complete the piece. They are then sent to the cost department. The data on both sides are transferred to the stock order, Fig. 2; these are made out on Fisher billing machines, making as many carbon copies as there are departments concerned and copies for the superintendent's, storeskeeper's and cost-department files. These orders are then distributed to the respective foremen. They each have a drawer-card file with guide cards for piece numbers by tens. They are then filed under respective piece number. The rough storeskeeper on receipt of his copy delivers to the foreman having the first operation, either castings or bar stock, as the case may be; enters the weight and the kind of material and returns his copy to the cost department. An operation card, Fig. 3, is then filled out from the order; a different card for each general operation, as lathe, drilling, milling, etc., at the same time entering the estimated time for the particular operation on its own card. These are made simultaneously with the sending of orders to the factory.

Collecting Time Data

The cost room is connected with every department in the factory by telephone. A time clerk, Fig. 4, wearing a head receiver and breast transmitter, sits before a desk, the top of which is divided into compartments, one for each department in the factory. These boxes, Fig. 5, contain numbered guide cards corresponding to the employee's key number. There is a subdivision in this box and in the forward subdivision the operation cards are filed numerically under their respective departments. These represent the orders on which work has not yet commenced. As the foreman assigns an order to a workman he takes the order from his file and, turning to the telephone, calls "time" to the exchange operator and is connected with the time clerk. He calls off "order 15,855," the time clerk reaches for the card and calls back to the foreman, "piece 165." This checks both men as having the same order. The foreman then says, "No. 216, first operation, last job complete." The time clerk enters No. 216 on this card and puts down the time and places the card behind guide card No. 216 and takes out the card he had been working on previously, enters the elapsed time and puts the card aside in a "finished operation" box.

Checking Operation Time

Boys in the factory shortly commence reporting by 'phone, "No. 216 produced four pieces." His operation card is referred to and this shows when he commenced and it is seen how long he has taken to perform this operation on the four pieces. This is compared with the estimated time shown on the same card, and right here is the kernel in the nut; if he is not coming up to the estimate, operation report, Fig. 6, is filled out, showing the estimated time and actual performance, and sent to the superintendent. The matter is taken up at once and, in practically every case, it is possible to get the estimated time on the remaining part of the lot. A lot of, say, 50 pieces might have cost $12 or $15 if allowed to go unwatched but, by following it up at the moment, the lot went through with a cost of $3 or $4, a clear saving in labor of $8 to $10. No cost system that allowed days or weeks to elapse could possibly obtain these results.

FIG. 4. TELEPHONE TIME-KEEPER AND HIS DESK

One of the greatest wastes in this country today is in labor-time loss. No executive would tolerate for a moment having his purchasing department paying $5 for articles that could be bought of

an equal quality elsewhere for $2. The same executive pays $10 in labor cost for product that he might be getting for $2 and yet he does so without a protest. It seems that his cost-accounting methods are overlooked, or he has utterly failed to grasp the real significance of cost accounting in its best sense. It is inevitable that the next few years will either find him aroused or out of the race.

Cost Summary

The cost-summary card, Fig. 7, is printed on both sides, detail of labor, appearing on the back. This is the permanent-record card on which all cost data are assembled. This is filled out in the heading at the time the order is issued and is, in fact, a ledger-account card, pure and simple. Card drawers fitted with 10-90 numerical guides are the ledgers. These cards are filed numerically, with detail-of-labor side to the front, before any operations have commenced. Other drawers are arranged in the same manner and these are journals. As fast as time cards come from the telephone desk, they are extended and filed under their proper numbers and all material requisitions are filed in the same manner. These are then posted to summary cards and these cards at all times show the exact amount of labor and material expended on this particular piece. This summary card and the one card in the telephone desk, showing operations under way, will give the value, requiring not more than two or three minutes' time and here is accomplished the desire to have costs absolutely abreast of the work in the factory.

An inventory may be made at any time of material under construction and the exact cost determined without estimating the value on a single item, regardless of whether there are 1000 or 10,000 parts under construction. How many large factories there are that take inventory of material under construction by going around, counting, weighing up and guessing at its value in present condition. With this system an absolute inventory of material in construction can be made without walking outside of the cost department or seeing a piece.

Tracer System

The question may arise here, "How do they know all the pieces are there?" Some may have been lost, spoiled or overlooked." This is another troublesome point in a factory. Many times when a quantity is incomplete, it will be found that two or three pieces hold up the completion of the final equipment for which they were intended, until they can be replaced, which means a long time. To provide against this, a tracer system is used. No material may be moved from one department to another without the foreman forwarding it issuing tracer sheet giving quantity, etc. No trucker will deliver material without the foreman for whom it is intended, signing it. No foreman will sign a tracer sheet until he has verified the quantity and, if it is found one or two pieces short, it is placed directly up to the foreman who forwarded it and he is responsible. Where material is spoiled, it enables the superintendent to issue a replacement order, "account of bad work," or "account of bad casting," to be carried through on this order to the department where the loss occurred and there followed through on the original order. These tracer sheets are sent in to the cost department and posted on a material-tracer card, which also was made out at the time the order was entered. These cards are kept in cabinets in the superintendent's room and he is able at any time to locate any piece in the factory without leaving his room and, farther, to know whether it was delayed at any point and the length of the delay.

ORDER NO. 12536 — Estimated Time Each 40 MIN. PER HOUR — Pan OPERATION REPORT — Actual Performance 48 MIN. PER HOUR — NEW MODEL PIECE NO. 2 — 5/8 TUR.

Date MAR 10 1909 — Operation No. 2

Department PLANING

Workman No. 462 Name J B Mead Machine No.

Remarks Time for three pieces only. 50 in lot

W. S. KOONES Time Clerk.

SUPERINTENDENT'S FINDINGS

MACHINE UNDER REPAIRS
OUT OF STOCK
BAD STOCK
GRINDING TOOLS
OPERATOR ABSENT
OPERATOR SLOW
BELT TROUBLE
NO JIGS
IMPROPER TOOLS

This form must be filled out and sent to Superintendent's Office at once in every case where operation is not being performed in estimated time.
Reports must be made on each ensuing day if output is not restored to estimated time or estimate is changed by Superintendent.
American Machinist, N.Y.

FIG. 6. FORM FOR OPERATION REPORT

FIG. 5. CARD FILE AT TELEPHONE DESK

Performance Records

After an estimate has been made on a piece, the time is also copied on a card, operation comparison, Fig. 8. The actual performance on the order is also posted to it and the next time this particular piece is to be duplicated, this card is taken out and the original estimate entered on the requisition. This gives a uniformity to estimates. If a piece were to be made 20 times, it would always bear the same estimate unless the estimate was ordered changed by the superintendent, in which case the change would be noted on the comparison card and the benefit of all the previous performance is gained. The superintendent is working with definite knowledge regarding every piece and every operation. It is just the difference between a navigator taking his ship through dangerous shoals without any experienced pilot or skirting an uncharted coast; if he strikes a rock "he didn't know it was there;" and the skilled captain who sails a charted sea, knows the dangerous spots and brings his vessel through unharmed.

Automatic Product

The method of handling automatic product is somewhat different. In this case, one operator is caring for from four to

six machines and the machine is considered as the individual and the operatot is disregarded. An exhaustive test of this department was taken in which the cost of operators, supervision, indirect labor, repairs to tools, depreciation, proportion of scrap material and average proportion of idle time of machines were considered and, as a result of this test, a fixed rate per hour was set for machines and a price per pound for the very small screws, pins, etc. The cost is figured by the piece on all the larger automatic product. This is ordered by storeskeeper on the same "requisition for order" in space provided, and the proper tooling equipment is checked and estimated output entered. Then the "automatic product" card is substituted for "operation card." Setting-up time is reported by 'phone and all idle time and the actual operating time separate. Outputs are reported on in the same manner as with men, and operation reports are made out in all cases where the output is falling below the estimate. This card combines the summary in itself and becomes a permanent part of the records.

It is a common occurrence in shop practice to take a man away from one job to do some rush work that may require only 15 or 20 minutes. To provide for this, a "stop and start" space is provided on the operation card. When a foreman stops a workman he 'phones in, "workman No. — stopped," and gives the new job as well. The time stopped is entered in its proper space for the day concerned, and when he is started on the job again, it is reported and entered, and at the end of the day these stops are totaled and deducted from the total time. The finished cards are put aside and the total time for the day, as shown by distribution, together with the current card for this employee, compared with time credited to the man on the time clock. The

Card No. 3 — OPERATION — ESTIMATED TIME EACH COMPLETE 105 MIN. / HOURS — COMPARISON — PIECE NO. 76 — SIZE OF MACH. 2 3/4 Tur — STYLE OF MACH. NEW MODEL

NAME Gear — Kind of Matl. C. I.

ESTIMATE: Time of Operation for One Piece					PERFORMANCE																	
						Date	3/11-09															
						Stock Order No.	16943															
						To Apply on M. C. No.	674															
						Quantity	75															
1st Oper.	2nd Oper.	3rd Oper.	4th Oper.	Complete Operation Hrs.	Min.	OPERATION	DEPT.	Jigs	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.	Hrs.	Min.
						Lathe	1st F. Lathe															
20	30				50	Gisholt	2nd F. Lathe			52½												
6					6	Drilling	First Vise			6½												
						Laying Out	Second Vise															
						Planing	Third Vise															
45					45	Milling	Feed Bracket			46½												
						Grinding	Splnd. Head															
4					4	Polishing	Tool Room			4												
						Forge	Experiment															
						Boring																
						Vise																
						Power Press																
						Hand Machine																
						Bolt Cutter																
				105		Complete Time				107½												

American Machinist, N. Y.

FIG. 8. FORM OF OPERATION COMPARISON CARD

ORDER NO. M.C. 674 SPL. 16943 M.

COST SUMMARY

QUANTITY ORDERED 75 FINISHED

PIECE NO. 76

No. No.

SIZE OF MACHINE 2-3/4 Tur

NEW MODEL

NAME Gear

For

Date Completed Date Begun 3/11/09

MATERIAL	Weight	RATE	AMOUNT		COST OF LOT	COST ONE PIECE
Castings - Iron	1800	2¾	49 50	Cost of Material		
" - Brass				Cost of Labor		
" - Bronze				Overhead Expense		
" - Mall.						
" - Steel				Total		
Forgings				Bad Work		
Automatic Product				Bad Design		
Iron				Bad Casting		
Steel				Total Cost		
Novo Steel						
High Speed Steel						
Brass						
				Cost Selling Price		
				List		
				Profit		
				Profit Per Cent		

BAD WORK, DESIGN OR MATERIAL

NO. PCS.	OPER.	KEY NO.	HRS.	LABOR	MATERIAL

Totals

Remarks:

OPERATION	DETAIL: KEY NO.	NO. HOURS	O. T.	AMOUNT	TOTALS: TOTAL HOURS	TOTAL AMOUNT	EFFICIENCY: NO. PCS.	MIN. EACH	STND. MIN.	PER CENT	CK.
Lathe											
Drill Press	397	7¾		1 40					6		✓
Milling Machine											
Gisholt	45	65½		16 37					50		✓
Planer											
Bor-Mill											
Chuck'g											
Gear Cut	337	58¼		13 10					45		✓
Grinding											
Polishing									4		
Black-smith											
Shaper											
Key Seat											
Automa'c											
Testing											
Fitting											
Stock Parts											
TOTAL									105		

ORDER NO. 16943 — DETAIL OF LABOR — PIECE NO. 76

American Machinist, N. Y.

FIG. 7. COST SUMMARY CARD FORMS

MACHINE Drill Press SHOP NO. 926
MAKER Hamilton Machine Tool Co SIZE 42 inch SERIAL NO.
BOUGHT OF Do W H Welch C. S. NO. 4338 INSTALLED May 1907
DESCRIPTION complete with b. g., f. f. and auto stop LOCATION 1st floor BLDG. E
REMARKS and f. g. tapping attachment COUNTERSHAFT ✓

INSTALLATION	AMOUNT		DETAIL COST	TOTAL COST
FREIGHT	15 36	INVOICE PRICE OF MACHINE	475 00	
CARTAGE	2 00			
FOUNDATION	12 56	ATTACHMENTS		
ERECTION	6 42	Friction geared tapping attach	85 00	
	36 34			
SPECIAL TOOLS				
		COST OF INSTALLATION	36 34	
		COST OF SPECIAL TOOLS		596 34
		APPRAISED VALUE		

American Machinist, N.Y.

FIG. 9. FORM OF CARD FOR PLANT ACCOUNT

time shown by the time clock and entered on the payroll must be accounted for on the operation cards. A man sent out on an errand is reported in the same way and a card made out; also, for cleaning up machines. After being posted to "detail of labor," they are kept only a short time for possible reference and then destroyed; the summary carrying all this data is the permanent record. A great number of operation cards are used per month, and if they were saved, it would require an enormous filing capacity and it is unnecessary.

General Features of the System

There are no standing orders. Every jig, fixture, new shop tool, or repair on tools or machines requires a separate order. Requisitions for this class of work originate with the foreman requiring the work, or with the superintendent. The routine is the same as with stock orders.

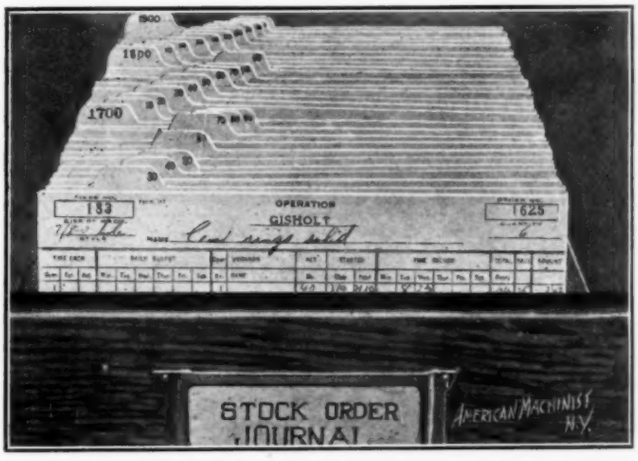


FIG. 10

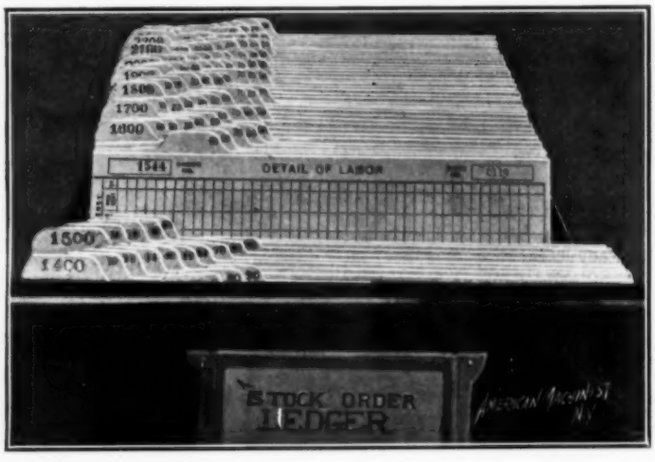


FIG. 11 LEDGER DRAWERS

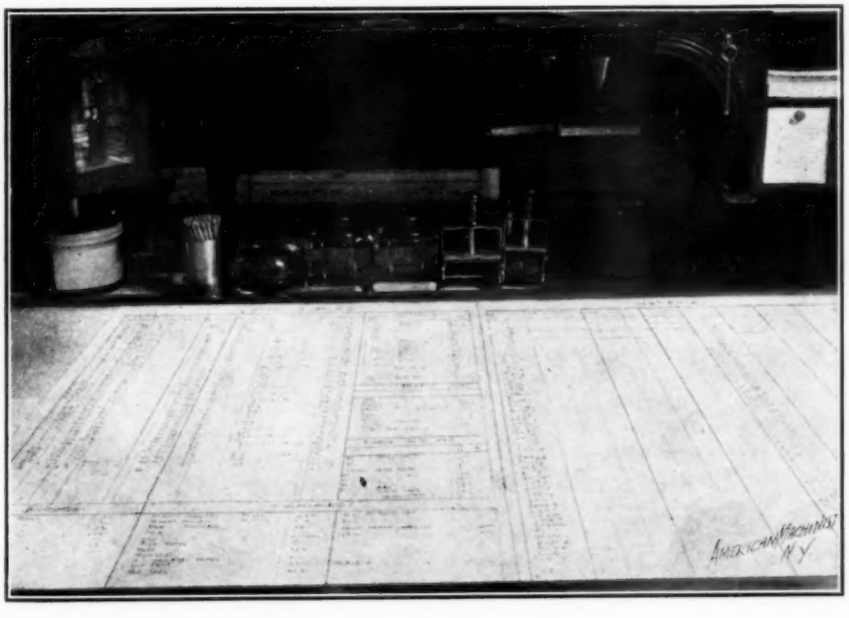


FIG. 12. DESK TOP, SHOWING MATERIALS AND SUPPLIES DATA SHEET

The summary cards on this class of work are filed in "general ledger" drawers and, upon completion, are filed under department subdivision under their proper classification.

Jig and fixture cards are filed with "plant A/C records." All machine tools or equipment in the factory are carried on "plant" cards, Fig. 9. Each machine is identified by its shop number on the card and a complete detailed description of the equipment, installation, and any other data concerning the machine, is entered. Any alterations that may be made on the machines at any time are recorded on this card, making a complete history of each.

Monthly statements are prepared, showing the total expenditures on all classes of work, and carried in "general ledger" drawers. Each classification is subdivided into departments. Shop supplies, bad work, bad castings, etc., are shown in the same way. All labor is classified, giving total hours and amounts for each classifi-

cation. With these data it is a simple matter to compile the most complete statistics regarding labor, average wages for each class, production, earning power, profit to the company per man, proportion of expense per productive hour, etc.

An analytical report of the factory operation is made out. This has 13 columns; it covers the entire fiscal year and details all expenses under general headings, as power, drafting, stockkeeper, general supplies, maintenance and these, in turn, subdivided into details. As, for example, "power" is subdivided into labor, fuel, water, belting, lubricating oils, maintenance of power machinery and supplies. The proportion of overhead expense cost is determined from this, both as a ratio against productive labor total and, also, shown as an hourly cost based on total productive hours. The overhead proportion used on the cost summary is based on this report.

Two copies of the original stock order are kept in the cost department. One copy is filed numerically between 10-90 guides; the other copy is filed by piece number and general shop-work classification. The cardinal numbers, one, two, three, etc., signifying castings, with the prefixed cipher signifying steel parts, and a double-cipher prefix denotes bronze. This double classification makes a cross-file index to the work in the factory and is subject to constant reference and prevents duplication of orders.

A telephone operator on this work has an average of about 50 calls an hour and, in that time, locates the correct card and makes the proper entry and refiles. A table of elapsed time under a glass cover on the writing surface of the desk serves to verify his mental computation of time. Lapses are always figured to the nearest quarter of an hour.

All rate extensions on the cards are made by use of a rate book which was worked out in this department a few years ago, as being better adapted for this work. It is arranged on a decimal system, all rates appearing on each page and each page covering a period of 10 hours, and other features for instantly locating the amount. The book has since been published and is known as "Rich's Twentieth Century Wage Tables."

One of the essential features of the successful operation of any cost system is a well organized stock room. There may be branch store rooms, but they should be under control of the general storeskeeper and all stock should pass through his hands for record.

While this system has been applied to the Cleveland Automatic Machine Company on a strictly day-work basis, it can be applied equally well to factories under other wage systems. The general principles of this have recently been adopted by, and applied to, an automobile factory employing 700 or 800 men and having a large percentage of piece-work and premium-plan labor, with entirely satisfactory results.

At the present, with close competition and small margins of profit, it is essential that the factory executive have the most intimate understanding of the details of his factory and, thus equipped, he is able to direct affairs fortified with exact knowledge and the cost department, maintained at a standard to supply him with this information while the iron is yet hot, is one of the most productive departments in the shop; otherwise, it degenerates into a compiler of musty records and, very properly, is classed as nonproductive labor.

Figs. 10 and 11 show two ledger drawers, typical of the arrangement of ledger cards, and Fig. 12 shows a desk top having a large sheet under glass giving the net prices for materials and supplies and used for pricing requisitions.

In a report from India it is stated that not far from the city of Chittagong natural gas issues from a crevice in the ground in considerable quantity. It has been burning so long that the oldest inhabitant can give no idea of when or how it was set on fire. The general belief among the natives is that the gas has been on fire for centuries. It is now suggested, and some steps have been taken to carry out the suggestion, that the fire be extinguished and the gas be brought under control, and piped for lighting, fuel and power purposes.

Melting of Steel from the Interior

By G. P. Blackiston

The real true meaning of that great saying of Lemierre, "It is a profound error to presume that everything has been discovered; it is to take the horizon which bounds the eye for the limit of the world," was never more forcefully illustrated than by the recent discovery by the writer that steel, contrary to the general belief, invariably melts from the interior.

Such a statement no doubt, appears somewhat absurd or unreasonable to the novice or even those better informed upon the subject of steel in general, but who have never had the pleasure of close-

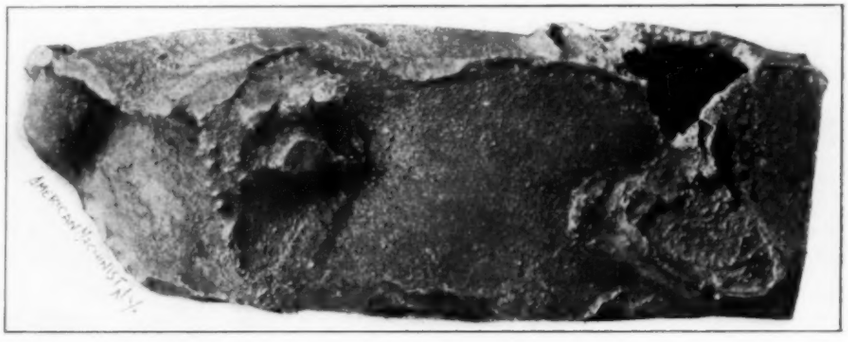


FIG. 1. FLAT BAR MELTED FROM THE INTERIOR

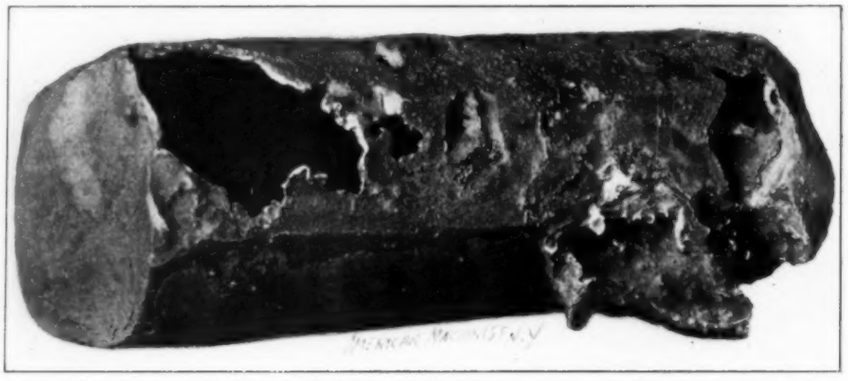


FIG. 2. OCTAGON BAR MELTED FROM THE INTERIOR

ly examining this strange phenomenon. In view of the doubt which may exist in the minds of some, I show herewith two halftones of pieces that were taken from the furnace partly melted; one a flat, the other an octagon bar. Both were hammered bars of crucible steel.

Close examination of these reveal the fact that both are hollow on the interior, while the outside surface still retains, in general, the original shape of the bars.

The fact was first discovered by the writer some years ago while experimenting with a new type of the Kirkwood oil furnace. The charge, composed of steel and iron scrap, having been placed in the melting furnace and subjected to an intense heat, was examined at regular in-

tervals to ascertain the effect upon the charge.

Desiring to examine a portion of the charge at closer range, before it had become fully molten, a portion of same was removed from the furnace and permitted to become cool. As the pieces composing the mass had become closely adhered to one another, it was necessary to break the several pieces of scrap apart. It was here that the bars of iron and steel were found to consist of mere outer shells—the interiors having evidently become molten and escaped through holes (weak spots) in the surface to the bottom of the furnace.

Examination of the different bars revealed the fact that the thickness of the shells varied materially in ratio to the composition of the product—the high-carbon bars being thinner than those of the lower or softer character. This, of course, was expected, due to the great difference in the melting points of the several bars.

Fearing that this phenomenon might be occasioned by the oil fuel as used in the Kirkwood furnace, I immediately started extensive experiments in other style furnaces and with all grades of scrap and fuels. The final results were the same as regards the melting of the interior before the exterior. In these tests, crucible, open-hearth and special furnaces were tried with the same satisfaction.

It was, therefore, not a mechanical, but a chemical result. With this in view, a complete series of experiments or tests were made with the final solution that it was due to nothing other than the oxidization of the surface which naturally raised its melting point, while the interior remained in its former or original condition as far as its melting point was concerned.

This being the case the center naturally melted first, the melted metal forcing its way through a weak section of the outer wall. When the heat reached the necessary degree for the complete liquidation of the entire bar, the outer surface also lost its shape. The high-carbon steels naturally melted first, while the low-carbons followed; the wrought iron being the last to succumb to the flames.

At just what degree the several carbons began to melt upon the inside has not yet been definitely determined by the writer, due to the lack of proper facilities for the satisfactory solution of these points.

Whether such a chemical action is true with the Bessemer process, the writer doubts very much, not having however, fully tested the same to his entire satisfaction. It is possible that the force of the blast and the rapidity of action which is peculiarly characteristic of this operation, would somewhat obviate this strange formation.

No doubt in years to come, some energetic, progressive person will take advantage of such a natural reaction or change so-called, and make it productive of some value or use.

I am located in the Wabash building, Pittsburg, Penn., and would be pleased at any time to show the original pieces that were photographed for the halftones, Figs. 1 and 2.

Buying Machine Tools by the Ton

By R. E. Marks

There's a new man over in the Yanktown Manufacturing Company across the way and he's wearing a different handle from any man in town. They call him the "purchasing engineer," which means, I suppose, a cross between the old purchasing agent who "knew the difference between 99 cents and a dollar and not a d—— thing else," and the mechanical engineer who knew the best machine and didn't care two hoots in Hackensack what it cost. Seems to be a new science with him, sort of a compromise between the two, and he's figured it all out on a scientific basis so that he knows how much the average machine tool costs per pound. So when the superintendent wants a new milling machine and expresses a preference for any particular make, he trots out his "so-much-a-pound chart"—works his slide rule a few, and decides whether it is too much or whether the maker is a poor, deluded individual who is selling machines 7/10 cent per pound too cheap.

But he struck a snag the other day that rather jarred his anatomy in spots, and he hadn't fully recovered the last I know; seems to be revising his chart, or making a new one for emergency cases.

The superintendent reported that the new hollow spindles of the cider mill took altogether too much time and, worse than that, the holes didn't come true within a row of apple trees. Said they run as they are mighty apt to on long holes, and while they did well enough on the potato mashers, where the only object was to get daylight through and the working limit to keep them from breaking through the side, the new machines needed a straight hole.

So they sent out for bids on a special boring machine and the P. E. was interviewing the engineer from the shop who made them, when the earthquake came.

They hadn't rounded the first lap before the P. E. had his price per pound chart in working order.

"What's your price—$1000? What does it weigh?"

"Can't say exactly, 'twould have to be a little special for your work; probably 1000 pounds."

"A thousand pounds! Why, that's $1 per pound—outrageous price for a machine tool. Over four times what it ought to be. It's highway robbery, and I won't stand for it. What on earth are you thinking about?"

"Well, as long as you've asked, I'll tell you. I thought you wanted a machine to bore spindles, but it seems you're trying to buy pig iron. If I'd known that I'd made a different price. Now let me tell you how I buy machines—and I probably buy more in a year than you do.

"Suppose I want gear cutters. I go to a man and put it up to him like this: I want a machine to cut these gears, of the best quality, in the quickest time consistent with that quality and a machine that you'll stand back of. I don't ask what it weighs, how large the bearings are, or what color it's painted. I don't care whether it weighs 100 pounds or a ton, as long as he guarantees it to do the work and I feel sure he's good for the guarantee. I'm buying *his gear-cutting experience*, not cast iron and steel at so much per pound. If it cost $10,000 it has got to save more time than as though it only cost $1000, but what do I care whether it costs 2 cents or $10 per pound as long as it does the work?

"If I could buy an engine lathe that would do any work and only weigh 1 pound and take up 4 cubic inches of room, it would be worth more to me than the lathe I have to buy now. The price per pound would be rather high, but 'twould save me floor space and weight on the floor beams. I don't buy pig iron for tools; I buy *results*—results that have cost him more money than I want to spend in finding out what he already knows.

"You think $1000 is high for that drilling machine. Perhaps just as a machine it is, but it is more than that. It represents our experience of years in a line of drilling that mighty few know much about. That $1000 means not only the machine, but the result of all our many costly experiments in drills, in speeds, in feeds and in lubrication. It means a guaranteed production of work that represents the maximum output at this stage of the game.

"If the work the machine will do isn't worth $1000 to you, I wouldn't advise buying it. But I wouldn't go up in the air because the price per pound happens to be higher than you pay for a standard lathe. You're getting brains as well as cast iron and they usually cost more.

"Of course, I could load the machine down with junk if you want it, or would feel that you were getting more for your money. But don't get the idea that weight necessarily means value in the machine, as it may not even mean stiffness. I can make a machine twice as heavy by using solid legs, but the bed may spring just as much as it does without them. Cast iron is all right in its place, and the price per pound is a good thing to keep tabs on, but don't get the idea that because the price per pound seems high that the other fellow don't know what he's doing."

Seems to me there are several good, full grown thinks in the remarks made to the P. E., and while it somewhat disarranges the lines of the various charts, it gave him a new range of vision and one that ought to do most of us good.

The Production of Sound by Machinery

Discussion and Description of Some Mechanical Devices Designed to Talk and also to Transmit and Reproduce Spoken Words and Musical Notes

BY S. I. OESTERREICHER

The intention of this article is to give a brief summary of the various artificial ways by which sound may be produced and reproduced. By the word sound is meant mainly those audible vibrations emitted either by the human speaking organ or by musical instruments.

The idea, itself, to produce or to reproduce sound is by no means new. A positive record of an early form of speaking mechanism is of one made by the philosopher, Albertus Magnus, dating back to the thirteenth century. With the exception that it was termed diabolical and destroyed by St. Thomas Aquinas, very little is known about this device. Probably there were a number of others who secretly made speaking devices before and after that date, but being afraid of the punishment of those bigoted ages, took care not to make any unnecessary advertisement of them, carrying their well guarded secrets to the grave. Only when the wave of enlightenment electrified the whole civilized world, and scientists, such as Newton, Lord Raleigh, Helmolz, and others, laid down the fundamental laws of sound, did the inventors of the twentieth century tackle this problem, and once attacked, gave the world, in a short time, one of the greatest inventions of our age, the telephone. However before invented, in considering the intricate mechanism of the human speaking organ, as the lungs, throat, tongue, teeth, lips and nose, some people using their brains; all of which are put to work when speaking, scientists were well agreed that an apparatus capable of producing or reproducing spoken sound must be an intricate mechanism and the disappointment was at a high pitch when the simple instrument was first seen in public.

To such an extent did this sentiment manifest itself, that when in 1875 Mr. Edison, through his agent, M. Puskas, had his phonograph presented to the Academie des Sciences in Paris and the instrument began to speak and Puskas, considering, perhaps, the prominent part he played this time, exhibited some nervousness when handling the phonograph, some members of the great institute noticing his plight, misunderstood it, and said that the academy was mystified by the act of a clever ventriloquist. It should be said to the credit of the academy that the greater number of its members, believing that Mr. Edison would not lend his name to such a scheme, inspected the phonograph on exhibit very closely and officially declared that not the man, but the instrument did the trick.

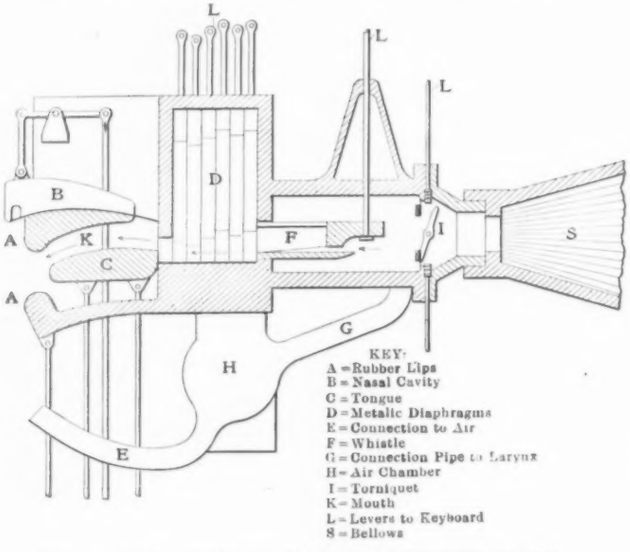


FIG. 1. FABER SPEAKING MACHINE, EXHIBITED IN 1877

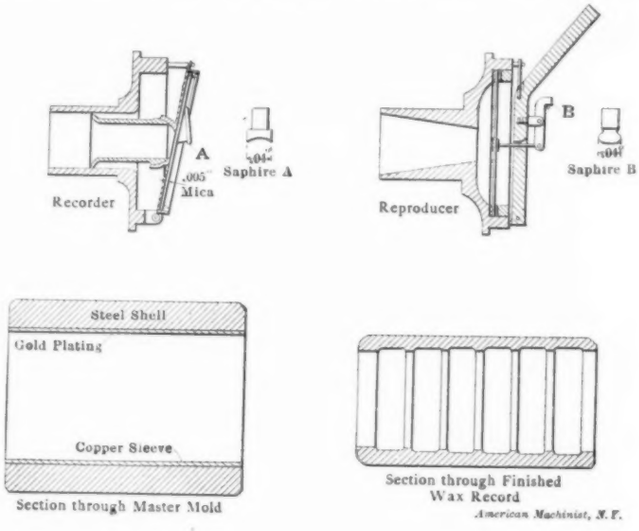


FIG. 2. EDISON PHONOGRAPH AND RECORD MOLD

A True Talking Machine

An important distinction must be made in sound-producing and sound-reproducing instruments, since the telephone simply transmits and the phonograph reproduces the sound, which is first spoken or otherwise recorded. A simple artificial speaking mechanism is still an open question; but since it seems that there is no need for such an apparatus, nobody cares, really, to make one, unless for the sake of curiosity.

It is well known that such an apparatus can be made, in fact one was made by a certain Faber and exhibited in Paris in the year 1877 at Houdin's theater. To give an idea of its main part it is reproduced herewith in Fig. 1, from Count du Moncel's book, "The Telephone." The speaking mechanism proper consists of a casing within which are arranged the necessary parts, as follows: At its right-hand end are the bellows *S* substituting the lungs The bellows open into what is known in the human throat, as the larynx. In the larynx we find a little air inlet-regulating valve *I*, the "torniquet." In front of *I* the "whistle," *F*, which communicates with the diaphragm chamber where the diaphragms *D* are housed. The left-hand opening of the diaphragm chamber leads to the mouth, within which are the tongue *C*, mouth cavity *K*, and at its left extremity the lips *A*, and above the lips the nasal cavity *B*. Underneath the apparatus is the air-supply pipe *E* with its air chamber *H*, and the connection pipe *G* leading back to the larynx. From all parts which move during the talking operation, levers marked *L* connect to a common piano keyboard from which the apparatus is controlled.

In pressing a certain key on the board the levers connecting the necessary parts for articulation of the sound, shape the lips, place the tongue, diaphragms and the whistle in their proper places, the torniquet opens, air rushes from the bellows through the whole system and out comes the sound corresponding to that key. It is said that

the "talking" of this apparatus was sufficiently clear to be understood. Its speed naturally, was governed by the skill of the operator. A detailed description of how the parts act when pronouncing certain letters would take more space than is intended to be given here, and it is, therefore, omitted. The apparatus, as a whole, is a masterpiece of skilfully arranged parts, an excellent study of physics being necessary besides, to the accomplishment of its arrangement. However, since no practical field can be found for such a speaking mechanism except for exhibits in a curiosity show and even there very often brings but meager returns, such an apparatus disappears from the public eye.

The Phonograph

In all sound-reproducing instruments the sound must be recorded first, and the so recorded sound again reproduced by proper means. The recording process can be accomplished, either by mechanical or electrical means. The electrical means may again be subdivided into electromagnetic, electrochemical and electrophotometric.

All sound-recording instruments have one identical part—the diaphragm used as the transmitting and transforming medium to the record. It is well nigh impossible to even touch upon the theory as to what happens to the diaphragm when struck by the sound waves. There is still very much to be accomplished on this subject, notwithstanding the fact that Newton, Lord Raleigh and a number of others investigated this, and although given many data by which to work they have still left much to be done. Not even has Cladni's important discovery of making the vibrations of circular membranes visible when struck by sound waves, by means of sand strewn upon the vibrating plates, which forms itself into beautiful shapes, brought us any nearer to the solution of this problem.

What is generally known should, therefore, be accepted; that a diaphragm made of a solid elastic material, clamped tight at its circumference vibrates most intensely at its center, when struck by sound waves, thus transforming this sound phenomenon into a dynamic energy of considerable force capable of making indentations on properly selected materials. The diaphragm can be made of any hard material having sufficient elasticity to be capable of vibration when struck by sound waves; sheet iron, copper, mica, malleable glass, celluloid, wood, etc., making very satisfactory diaphragms. The diameter and thickness of the diaphragms vary greatly. Variations of from 1¼ to 2½ inches diameter and from 0.005 to 0.03 inch thickness are of daily occurrence, this proving the wide divergence of opinion which exists among makers of this type of instrument.

In the mechanical process of making sound records, the diaphragm carries a device such as a needle, stilus, or sapphire, which cuts into the record grooves of various depths, some of these not deeper than 0.001 inch. Two methods are generally adopted; one by Edison, where the record is cylindrical in shape and the grooves are cut radially toward the direction of motion; the second by Berliner, where the record is disk shaped, and the grooves are cut tangentially toward the direction of motion.

Since the record must touch the recorder to receive the indentations, there is friction between the two. This frictional energy presents itself very unpleasantly when reproducing, and cannot be entirely eliminated. All kinds of schemes were tried to lessen the friction, but up to date with little success. Recent reports from Germany state that a method has been tried where compressed air is employed between the record and the recorder; this is supposed to eliminate nearly all the unpleasant grating.

When Mr. Edison's phonograph was

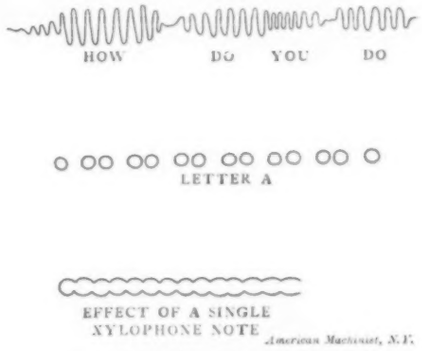


FIG. 3. MAGNIFIED SOUND RECORDS

first shown in public it was a very primitive apparatus. It had to be driven by the operator by means of a small crank attached to a shaft and a small flywheel placed on the shaft regulated the speed of the revolving cylinder. At the time of the introduction of the first apparatus it carried no wax record, a sheet of tinfoil being used instead. Later on, this hand-driven mechanism was superseded by a clockwork, which gave a uniform motion, far superior to the first method. The next step was the substitution of the tinfoil by the wax-cylinder record, which was far better suited to receive the fine indentations of the tracer than the sheet of tinfoil rolled around the cylinder. Improvements were made successively upon this device and at present it has no resemblance to its predecessor.

The most popular form of this instrument consists of a spring-motor-driven mechanism, mounted in a wooden box, belt connected to a horizontal cylinder carrying the record. The cylinder makes no lateral movement as this is done by the recorder or the reproducer which is carried in a lateral direction by a screw forming part of the shaft on which the cylinder revolves. The screw has 100 threads per inch. The motor drives the shaft at 160 revolutions per minute. The outside diameter of the wax record is 2¼ inches. This would correspond to 19 inches peripherical velocity per second for recording or reproducing the sound. The matter of speed is the most important point to be observed, since this velocity is strictly linked with the pitch of the sound. The slightest deviation from this speed makes quite a difference in the pitch.

The recorder and reproducer are designed to execute their respective functions. Attention is called to the recording sapphire *A*, Fig. 2, which is hollowed to form sharp edges in order to cut into the wax record. The reproducing sapphire *B* is button-shaped, in order to follow closely the indentations of the record. Both sapphires are about 0.04 inch diameter.

It is interesting to note here that notwithstanding the fact that the soft wax record travels at a considerable speed in front of the sapphire button, and the sapphire presses comparatively hard on the soft material, the particles of wax are not torn from their places, this being due to the fact that the energy acts but locally. A similar phenomenon is recorded in many textbooks of physics, namely, that a candle may be made to pierce a wooden board, if the candle hits the board with great speed.

Making the Records

Curious effects can be seen on the phonograph records when viewed through a microscope. Some of these effects are shown greatly magnified in Fig. 3. The wave expressing "How do you do" shows the vibrations of the diaphragm.

The Edison, as also the Berliner phonograph, found its place in our daily occupations, the greatest success being at present the entertainment given in reproducing music.

Naturally when it became necessary to supply records for such a great market as was created in time by these phonographs, the main problem was their production on a paying scale. Some of the most ingenious devices were invented to accomplish this end. The Berliner or disk-record manufacture is accomplished by making a die from the original so-called "master record" by means of photo-engraving. The dies are put into presses where the materials from which the records are made are pressed flat between the dies. The Edison record is made by casting the wax compound in molds, the interesting part of this method being the making of the "master mold." If we consider the fine impressions the original record has, it must be admitted that the mold is quite a fine tool for any toolmaker to tackle. Imagine a job like this for a man.

After the master record has been found to be correct it is gold-plated. The gold-plating apparatus, shown in Fig. 4, consists of a glass cylinder *A* hermetically placed upon a base, the air under the cylinder being exhausted by a vacuum pump,

through the pipe *F*. Before the glass cylinder is put in place four mandrels each carrying a master record *D* are placed on their respective shafts. Each mandrel has a little gear, this being driven by a main gear in the center, to which a bar magnet *C* is fastened. At the side of the mandrels a number of gold leaves *E* are suspended and connected through conductors to a secondary circuit of a pulsating induction coil. Outside the glass jar is a horseshoe magnet *B* fastened to a pulley and mounted on a frame.

After the master records are in place and covered with the glass cylinder *A* with the bar magnet *C* placed over all, the air is exhausted by the vacuum pump, the atmospheric pressure being relied upon to hermetically close the inside. The pulley turns the horseshoe magnet *B*, which in exchange attracts and turns the bar magnet *C*, and this again through the gears drives the mandrels with the records. The whole mechanism thus revolves at a low speed. The current supplied by the induction coil evaporates the gold leaves *E*, the gold forming a mist over the moving records. Since inside the glass cylinder a high vacuum exists, and in a vacuum moving bodies attract whatever there happens to be in the vicinity of their path, the gold dust according to this law gently and evenly settles over the entire surface of the wax records, gold-plating them in this way. The process lasts about four hours.

After being gold-plated, the records are put into a copper-plating bath and left there until about 1/32 inch thickness of copper has been deposited upon the gold. This gold and copper plating produces a thin shell of solid metal over the wax record, filling its finest cavities. After being taken from the copper-plating bath, this thin shell is warmed up to allow the removal of the wax record from the inside. There is now a negative record imprinted on the inside of this shell, the gold forming all indentations just opposite to those in the wax record, and held solidly by the copper shell. Next a strong steel shell is put over the copper shell to withstand rough handling and the master mold is ready for use in the record foundry. Semi-automatic machinery is used for casting the records in the foundry.

The Edison and Berliner method of sound recording or reproducing is by mechanical means; that is, the vibrations of the diaphragms are directly transmitted to the record by the dynamic energy placed by the sound waves on the diaphragm. It must be seen at once that in this method the energy losses are minimized to their apparent practical limits, since these losses are reduced to the resistance of the diaphragm and the friction between the record and the needle only; no other interposing medium being used (the air space which the sound has to travel until it reaches the diaphragm is not considered). However desirable this direct method is, for many reasons it cannot always be employed.

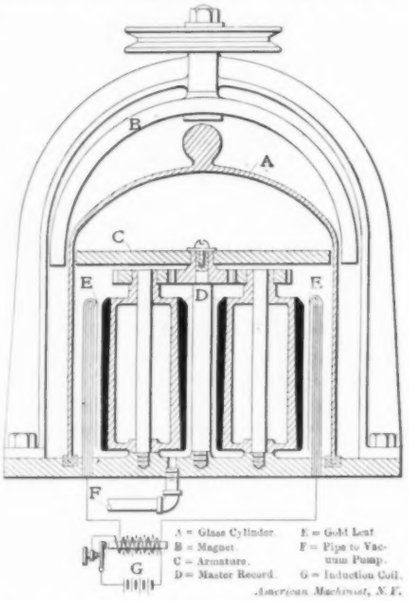


FIG. 4. EDISON APPARATUS FOR GOLD PLATING WAX RECORDS

Electromagnetic Methods

After the rapid success of electromagnetic wireless telegraphy, investigators at once set to work to try to transmit *sound* by wireless. Indirectly the electromagnetic phonograph was first struck upon. This phonograph consists of a strong magnet and an endless iron strip moving in the air gap of the magnet. When sound waves, properly directed, hit the air gap the magnetic field is distorted, thus unevenly magnetizing the moving iron strip. If, afterward, the iron strip is moved between two spools wound with wire, it induces current in the winding, in direct proportion to the magnetic strength and speed. If connected to a telephone receiver, the current is capable of reproducing very faintly, the sound recorded upon the iron strip. A great number of experiments were made with this electromagnetic phonograph, but up to date with no great success.

Electrolytic Methods

After Poulson published his researches with this phonograph, Doctor Nernst and Prof. R. V. Lieber took up the subject, and developed the electrolytic phonograph, and Lieber published his researches in the *Zeitschrift fur Electrochemie*, in 1901.

The form of the apparatus employed by Doctor Nernst is reproduced in Fig. 5. It consists of a microphone *M* connected in series with a battery *B* and with a primary of an induction coil. The secondary of the coil leads to the outside of a double-pole, double-throw switch. The opposite poles of this switch connect to a telephone receiver *T*. The center of the switch is connected to the electrolytic cell with one pole and to the record *P* with the other, which, in this case, forms the cathode of the cell. To connect in circuit with the electrode *E*, the wooden block *H* carries a metallic center, with one end touching the cathode, and the other end leading into the electrolyte, forming thus a closed circuit. The record forms a belt between two small metal pul-

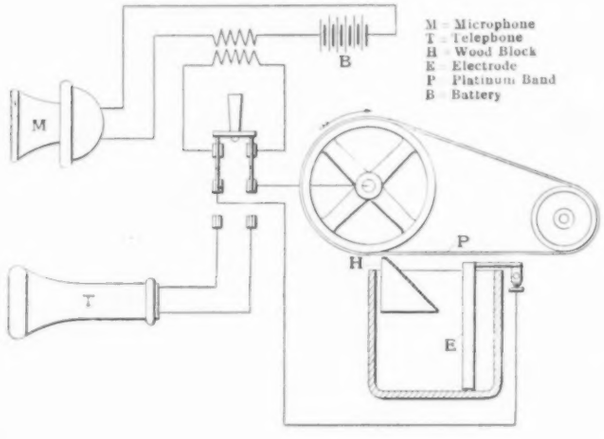


FIG. 5. NERNST ELECTROLYTIC PHONOGRAPH

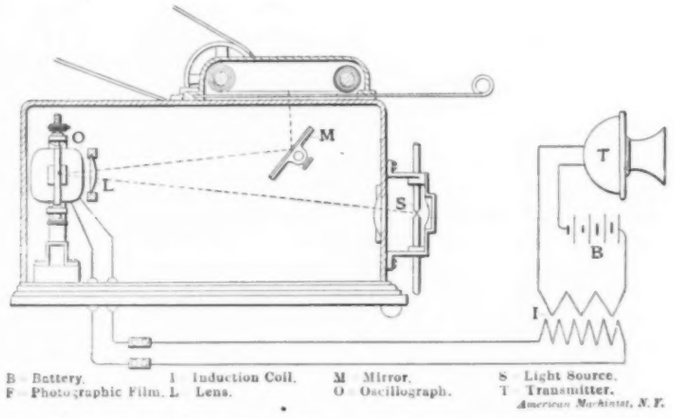


FIG. 6. ELECTROPHOTOMETRIC APPARATUS FOR RECORDING SOUND WAVES

leys, which are driven by some source of power.

When recording the sound, the microphone sets up a current of corresponding strength which is led through the cell. Electrolytic action takes place, and metal is deposited upon the moving record *P*. If reproduction of the sound is desired, the switch is thrown over and the formerly deposited metal particles, upon the cathode, react through the cell upon the telephone receiver, thus reproducing the sound. A great number of various metals were tried by R. V. Lieber, as electrodes, with a corresponding number of electrolytes, some of them giving excellent results. One of these consisted as follows:

Electrolyte: A solution of a zincate, by dissolving zinc sulphate ($ZnSO_4$) with potassium hydroxide (KOH), and dissolving the deposit in the surplus of potassium hydroxide.

Cathode: Copper (Cu) periphery.

Anode: Zinc electrode (Zn).

This combination reproduced very plainly, even to the extent of a hundred times.

Although up to the present this electrolytic phonograph is rarely heard of, there is a great possibility for its utilization in the future. It could be used in connection with the telephone, for in case no one answered a certain call, a form of time element could automatically be placed in circuit on the telephone, which would set in motion the phonograph, thus recording the call. After this it would be necessary only to unhook the receiver and have it talk.

Electrophotometric Methods

In some cases it is desired to make records of a sound, having a very high frequency, where the vibrations of the mechanical recorder are not able to make close enough indentations upon the record. In such cases photometric or electrophotometric means are employed. The simplest of the photometric sound recorders is the tuning fork, carrying at its end a small mirror upon which a light ray is reflected. If this light ray is then refracted upon a sensitive light film, and the tuning fork be put in motion, the so refracted ray of light will follow exactly the vibrations of the fork and reproduce them on the film. It is then only necessary to develop the film, to obtain in a graphical form, the record of the vibrations of the tuning fork. A great number of different combinations are used for the accomplishment of recording sound waves with photometric help, mostly all of them giving good results.

In cases where such direct photographing of sound waves is impossible, intermediate devices are used for the transmission of sound to the recording instruments, and in most cases, with the help of electrical instruments. Such an electrophotometric sound-recording device is shown in Fig. 6, as designed by the writer. It could be used chiefly to record sudden variations of sound.

The apparatus consists of an oscillograph *O* connected to the secondary of an induction coil *I*, whose primary coil receives its energy from a specially designed telephone transmitter *T*. A light source *S* refracted through condensing lenses upon the mirror of the vibrator, in the oscillograph, and reflected from the mirror *M* upon the moving film *F* is the recording element. If sound waves are transmitted through the telephone to the oscillograph, the vibrator will move the light ray in a certain plane on the film. The speed of the film being known and kept constant, it is easy to ascertain the frequency of the sound vibrations per second. An oscillograph would be used on account of its very short natural period, which, with its high degree of sensitiveness, would be capable of recording sound waves of such high frequencies as could not be recorded otherwise. If a sufficiently strong light beam could be recorded upon the film and this film be led in front of a selenium resistance connected in series with an oscillograph in such a way that the changes in the resistance resulting from the light beam through the film, are able to vary the electric currents through the oscillograph and a telephone receiver, the apparatus would probably be capable of reproducing the sound recorded upon the film.

A number of other sound-reproducing instruments came to light lately, as the speaking condenser, the talking transformer, the singing arc lamp, etc., but since no recording element is employed in any one of these apparatuses, they are out of the scope of this description.

The Hot Saw as a Cutoff Machine

By H. Terhune

Every few months there is a description of some new cutoff machine or cold saw in one or another of the technical magazines, but I doubt if more than a small percentage of the readers ever saw a hot saw in use. As this machine is but little understood and often misrepresented, a description of it and some of the work it does may make its principles better understood. Its work should be appreciated, as it saves hundreds of dollars yearly in drop-forge plants, and rolling mills. A line cut of the ¼- to 4-inch hot saw made by the Billings & Spencer Company, is shown in Figs. 1, 2 and 3.

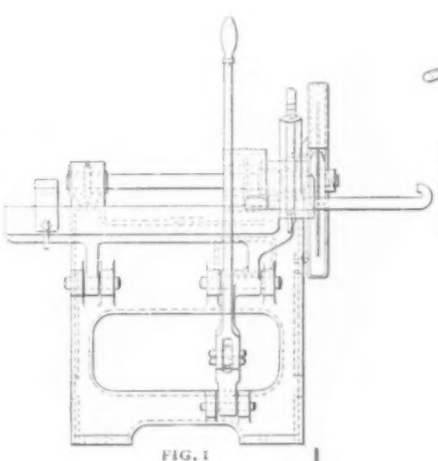


FIG. 1

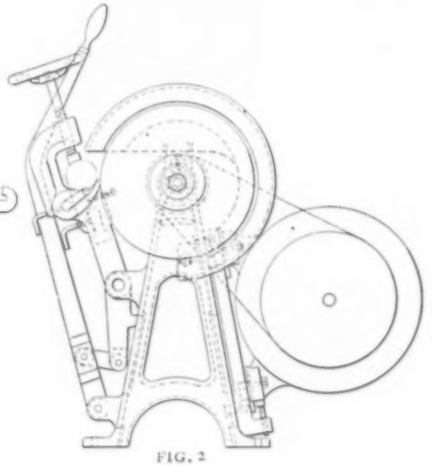


FIG. 2

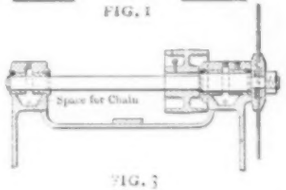


FIG. 3

American Machinist, N.Y.

FIGS. 1, 2 AND 3. BILLINGS & SPENCER COMPANY'S HOT SAW

Fig. 1 is a front view of the machine counter driven. Fig. 2 a side elevation, motor driven. Fig. 3 a section of the spindle, bronzed bushed, chain oiled with large oil reservoirs and a plug for drawing off the oil when necessary. The front bearing which carries the main load is long and heavy. The driving pulley is close to the front bearing so that when the machine is motor driven, the motor can be set as far as possible from the sparks, although these are largely taken care of by the saw guard. The motor is mounted on slides, on the back of the machine, with screw adjustment for the belt, which is 5 inches.

The first questions almost everyone asks are, what kind of a saw is used, and does it not require a lot of regrinding? I thought the same when I first saw one working in the Bethlehem Steel Company's plant several years ago.

The saw used is like any ordinary metal-cutting saw, but without set or temper. Our saws are ⅛ inch thick, 20 inches in diameter. The regrinding depends largely on the speed, which we make 2500 revolutions per minute, and the one feeding it, and not on the heat as one would suppose at first sight.

FIG. 4. ¾- AND 1¼-INCH SOFT STEEL AS CUT

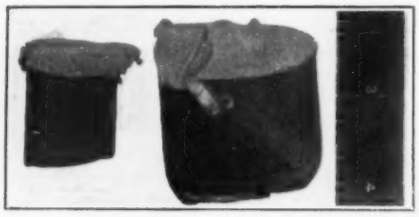


FIG. 5. ⅞- AND 1½-INCH SOFT STEEL AS CUT

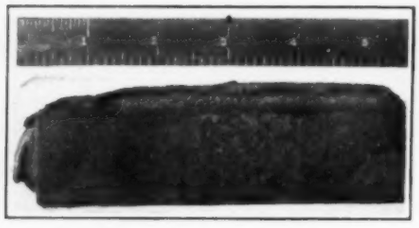


FIG. 6. BAR STEEL 1¼x5 INCHES SHOWING THE CUT

To make this clear suppose a 3-inch bar is cut when hot with a 20-inch diameter saw, or 62.83 inches circumference; any tooth would be in contact with the hot metal but 3 inches per revolution and would pass through 59.83 inches of air space, or, in other words, would be in contact with the hot work but 4.77 per cent. of each revolution. This means that what little heat could be imparted to the teeth, while in contact with the work, would have 95.23 per cent. of their time in which to cool off by radiation.

The actual time for a tooth to be in contact with the work is very small at 2500 revolutions per minute. On a 3-inch bar the time of the tooth contact would be but 0.032 of a second and thus the amount of heat imparted from the work to the saw would indeed be very small.

Some may argue that though small, if it is kept up continually, the saw would become hot, or, in other words, the saw would take up more heat than it could radiate. This is not true and has been proved wherever a hot saw has been used. We cut cold bar stock up to 1½ inches and pipe to 4 inches at the full speed of the machine. The bar or pipe will be heated almost instantly to a red heat by abrasion, for, say, ⅛ of an inch ahead of the saw, but if the saw be withdrawn and stopped as quickly as possible the teeth will be perfectly cold, while the bar will still be at a red heat.

Another experience under very different conditions also proves this. While working as a mechanic in the Manganese Steel Safe Company, Plainfield, N. J., some eight years ago it fell to my lot to experiment in cutting the threads on safe and vault spindles. These were made of manganese steel, which cannot be either turned or drilled, owing to its being very hard.

The question arose as to how to grind the threads. An emery wheel was tried, but this beveled to any certain angle, would last but for a moment. It was afterward found that a plain steel disk, beveled to the thread angle, without any teeth or corrugations, would do the work in fine shape.

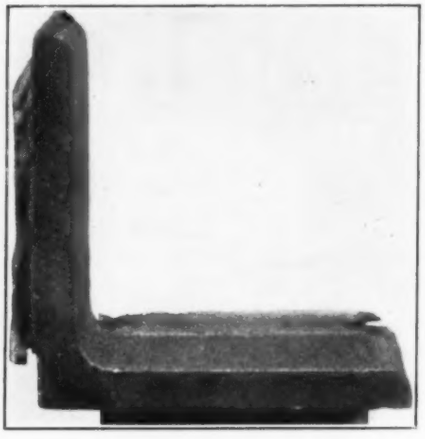


FIG. 7. SINGLE 3-INCH ANGLE IRON AS CUT

It not only left the thread sharp, but highly polished. The best results could be gotten when it was run dry, by simply running the disk at a high enough speed so that abrasion and radiation would do the rest. The work would be greatly heated, while the disk would be scarcely warm. Then, too, this disk was but 4 inches in diameter, and anyone doubting it can see the same work done there today. I trust that those who may read this, and did not know of it, may take the hint and be able to correct the lead of taps, after hardening, when called on to do so. The amount of stock to be removed would not be great enough to heat the tap.

Referring to the halftones of stock cut by this machine, compare the time with any cutting-off machine; even with high-speed tools and variable feed.

The bur raised by the saw can be knocked off in an instant on an emery wheel by a laborer, but if the piece is to be used for a forging, this is not necessary, as it would fuse off in the furnace.

If we consider the first cost, one cutting-off machine would cost more than two hot saws, with a furnace thrown in. The cost for fuel per furnace per day of nine hours for an oil fire will vary according to the size of the stock and how hard the fire is forced. For very small stock, say up to ¾ inch, the cost is as low as $1 per day, while in heavy work, say axles and crank shafts that may need two burners, the cost will run up to $3.50. Coal fires will be a little less.

Time for time, one hot saw will cut off more stock than a whole battery of cut-off machines. The machine is so simple that a laborer can run it, and yet it is made for hard knocks.

The halftone, Fig. 4, shows some soft steel ¾ and 1¼ inches in diameter that was cut, when cold, on the above hot saw, in 5 and 13 seconds, respectively; while Fig. 5 shows the same kind of steel, ⅞ and 1½ inches diameter, that was cut cold in 5½ and 37 seconds, respectively.

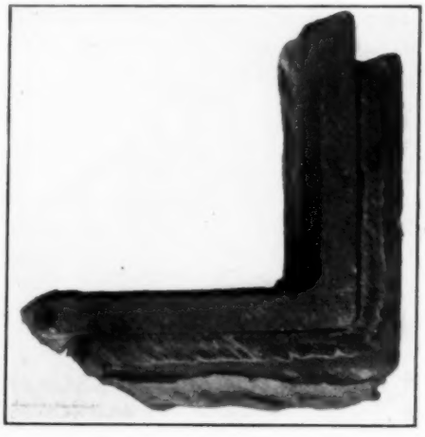


FIG. 8. TWO 3-INCH ANGLE IRONS AS CUT AT ONE TIME

FIG. 9. 3-INCH PIPE AFTER CUTTING

The cut in the bar of soft steel, shown in Fig. 6, was 1¼x5 inches, and this was cut cold in 25 seconds.

The saw also does good work, economically, in cutting up angle irons, and these can be cut more than one at a time. Fig. 7

shows a single 3-inch angle iron that was cut cold in 12 seconds, and Fig. 8 shows two of the same 3-inch angle irons that were cut at the one time in 40 seconds.

In Fig. 9 will be seen a 3-inch pipe that was cut cold in 18 seconds. The time that can be saved by heating the metal before cutting it is best shown in Fig. 10. In this the rail on the right of the picture was cut when red hot in 7 seconds, while the rail to the left was cut when cold and consumed 40 seconds of time in making the cut.

Following the Machinist's Trade is Brain Work

By Con Wise

I have come around to the conclusion that running a lathe, or a miller, or any machine-shop job is brain work, rather than manual labor. The old distinction between the two was, a brain worker washed his hands for amusement; a manual laborer because he had to. When chipping was resorted to, to make fits, and when erecting was done by brute force there was some excuse for characterizing a machinist in the latter way, but now when he wants to hoist anything he signals the crane man to come and lift it, and when he wants any chipping done he, just as likely, blocks up a ten-ton piece on a $10,000 planer and planes off in an hour what he could have chipped off in 15 minutes. It has long been a fact that the foxiest employers picked the little fellows to do their work on the ground that they handled themselves better and muscle was no longer needed. It has reached, now, the point where a dentist needs a lot more muscle for his trade than a machinist does, and a machinist needs more brains to understand his profession than a dentist does for his.

A few years ago I was using a sliding-key drive for the feed change on a radial drill, when one of our leading mechanics saw me and told me that such contraptions were a snare and a delusion. He said that he had tried such things and they were failures because machinists did not know how to take care of them. Today, in looking over the advertising pages, it is hard to find a machine-tool manufacturer who does not use vastly more complicated details and more of them than I then had any idea of. Yet they go, and they stay sold and they give satisfaction. Why? Just because our machinists have become better brain workers.

Fifteen years ago I hired the best scraper hand in town for $1.75 a day of 10 hours. Today I cannot get an equally good man for double the money. I mean relatively speaking. I can hire a man who would do what was wanted then, but what we want now is more brains, more head work. We are using systems of payment for work that 15 years ago we could not have used, because the workmen would have looked on us with suspicion. They were much like the Irishman, just over, who was offered a job at a $1.25 per day. "No sir," he said, "I work for a dollar a day, a hundred days a hundred dollars." Now they figure out how much they have made each day with their premiums or bonuses added, and do it so quickly and accurately that there is always danger of their getting promoted to some place where this facility will work in. The increase in brain power has run wages up tremendously, but nowhere near to the top notch.

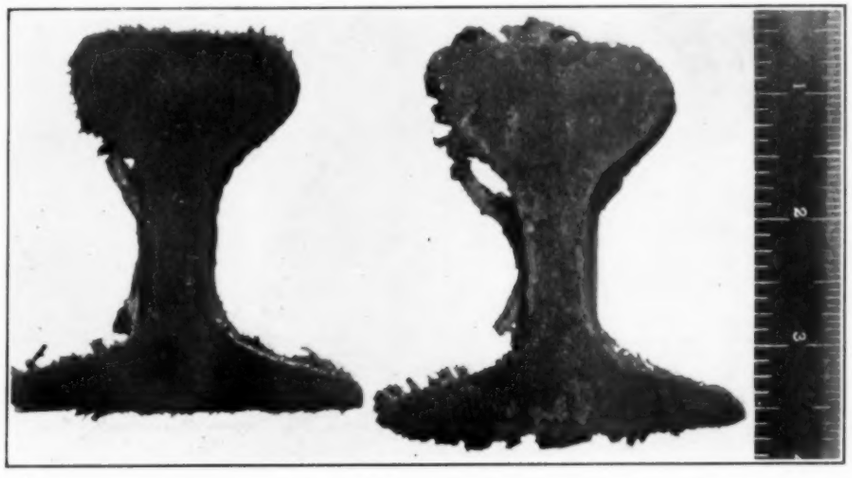


FIG. 10. RAILS CUT HOT IN 7 SECONDS AND COLD IN 40 SECONDS

Did you ever watch a pianist? He will sail along over the keys and in some way hit the ones that the author of the music intended he should, and at a clip that would make a typist blush. Now they tell me that the veriest tyro can take the most difficult music that Paderewski plays and pick out the right notes to play and can play it after a fashion. You might think that that was all the brain work there was to it; but they also tell me that no pianist can play faster than he can read the notes, and that habit or practice alone will not give the requisite speed to make the music sound musical. The real brain work that tires a pianist is in keeping the notes running from eye to finger with the proper regard to time and expression.

Now a machinist does not usually think with the lightning rapidity of a pianist at full speed, but any man who has tried piece work or premium work knows that the difference between the concentration of his mind on a job and having something else on his mind is a matter of dollars as well as cents in his pay envelop. A man who really wants to make money nowadays, of course, makes a bee line for a shop where a modern system of pay is used. To him every little expedient, the laying down of a wrench where he can pick it up easily, having the next job in mind while he is doing the first; all these little things that require more brains to look after than some of the big things, are what swell his week's wages. A machinist today needs to concentrate his mind on his work more than the accountant in the office with his adding machine. He needs to still more because his machine goes right on eating up stock if he is not right on the job, while the accountant's work will wait for him.

Another thing! The mere operations of turning, planing, drilling, etc., do not constitute a machinist's work. They may constitute the work of a specialist, but not a real machinist. A man may run a lathe and he may have satisfactorily done every job that was brought to him and yet be a long way from being a competent machinist. Until that man can take a set of drawings of a machine and produce what the draftsman intended to have built, he has no right to rank himself among the brain workers. The knowledge of what the best order is in which to perform a series of obvious operations on a piece is of more money value than the mere ability to perform any one, or all of them. Notice a tailor. Does he rank a man who can merely sew seams as a journeyman? No! A journeyman tailor can create a suit of clothes, and the planning and the cutting are the important parts. It is the men who can intelligently lay out and do a whole job in a shop that are scarce today. At the very worst of the recent depression I heard one of my neighbors say that he always had a job open for a man that could earn $3.50 a day, but he had more $2.50 men than he wanted, around.

I wish our manual-training school friends would please take notice and copy the above statement; then perhaps they would find out why their graduates have not risen any more quickly than they have, or why they have not had the courage to stick to their trade after graduation. The trade-school advocates might also profit from this same idea.

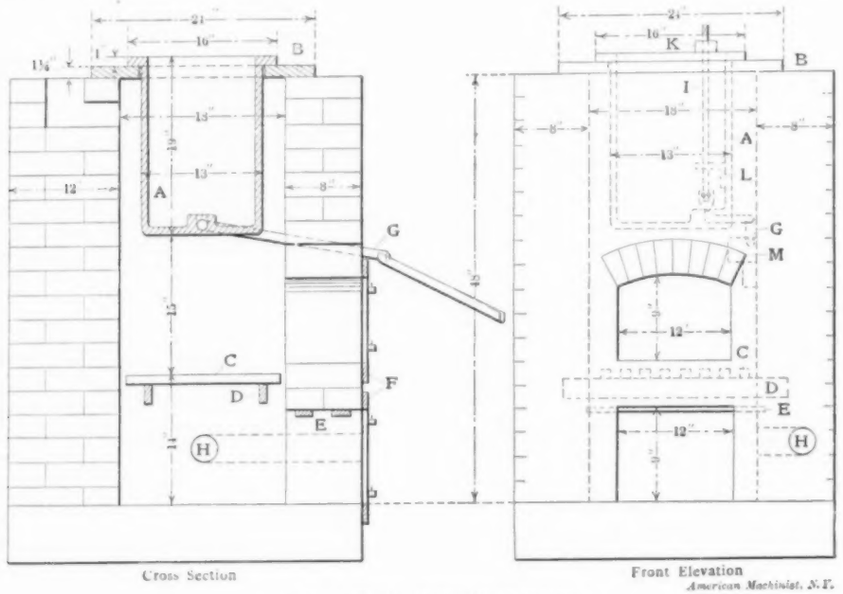
Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

A Novel Babbitt Melting Furnace

The accompanying line-cut shows a furnace used for melting babbitt in large quantities. It was designed for use in babbitting large pillow-block shells, cross-head shoes and like objects requiring a relatively large amount of babbitt. The main superiority is that the melted babbitt is drawn from the bottom of the pot, where it is clean and free from dirt or oxidized metal of any kind. The resulting clean bearings, free from porous spots, have more than repaid the original cost of installation. The company has three of these furnaces in a row for different grades of metal, and the metal is always ready to be drawn off at any time.



A FURNACE FOR MELTING BABBITT

A continuous fire is kept up at all times and the babbitt in the pot is covered with charcoal dust to prevent loss through oxidation. To start the fire an air blast is used, but this is shut off as soon as the fire is well started and natural draft is then used. The metal is kept at a very uniform heat during the night by banking the fire and a few minutes' use of the blast in the morning brings the babbitt back to a suitable temperature.

The whole furnace is cheaply built and assures the use of good clean babbitt at a minimum expense for fuel. Referring to the halftone *A* is a square cast-iron pot resting on a square cast-iron ring *B*, which in turn is resting on the brickwork. A piece 1½x2-inch flat iron *K* is bolted across the top of the pot and threaded ⅞ inch to receive the valve stem *I*, which is square on the upper end to receive a hand wheel with which to operate the valve. The valve seat is simply drilled into a boss cast on the bottom of the pot.

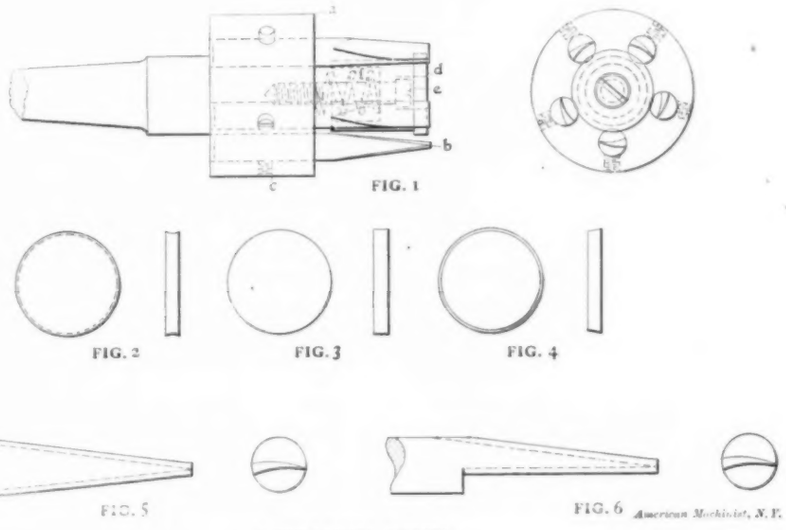
The valve disk is of round shape and loosely fitted on valve stem, held by two pins rotating in a groove. *G* is a ¾-inch pipe slanting to the outside. A long strip of sheet iron bent to a trough, is hooked on the end of this pipe and leads the babbitt to the job. The grate bars *C* are 1 inch square iron flattened on the ends to keep them in position. *D* is ¾x2-inch iron bricked in for the iron to support brickwork. *F* are door frames. *H* is the air-blast pipe. *L* is an angle to guide the valve stem. To protect the pipe from fire the brickwork is built out as at *M*.

Chicago, Ill. C. LAND.

A Vulcanite Cutter

The sketch shown at Fig. 1 is a cutter to be used in the speed lathe or drill press as desired, for the purpose of cutting vulcanite disks as shown at Figs. 3 and 4. Fig. 2 shows a disk which has been punched in a punch press. It is concave on the edges caused by the pressure of the punch in punching. By using this cutter it cuts the edge straight which otherwise would have to be turned, thus obtaining perfect blanks in one operation. Taper blanks can also be cut as shown at Fig. 4, which would also have to be turned if punched.

When a hole is required in the blank it could be punched first and a locating pin placed in the tailstock if used in the speed lathe, or if used in the drill press the locating pin could be placed in the table.



A VULCANITE CUTTER

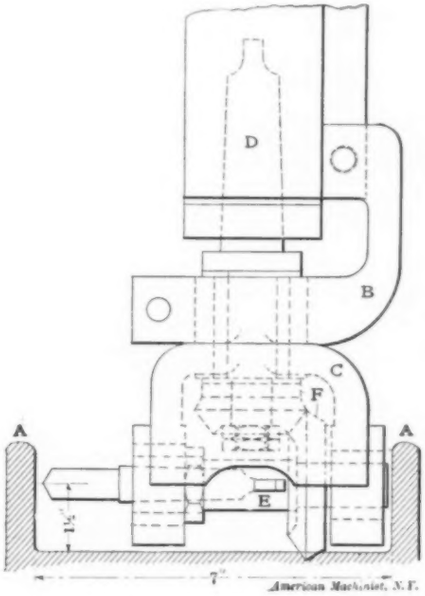
The cutter proper is composed of five cutters *b*, inserted in the holder *a*, and fastened with the five grub screws *c*. The knock-out *d* works free on the screw *e*, and is operated by the spring *f* at the back which throws out the blanks after being cut. To cut taper blanks a cutter as shown at Fig. 5, is to be used with clearance

ground both inside and out. For cutting straight blanks the cutter is ground straight on the inside instead of tapered and with clearance ground inside and out.

Montreal, Canada. G. H. H.

Drilling at Right Angles to the Spindle of a Radial Drill

An operation of common occurrence in many shops is the drilling of the flange of a machine frame from a confined space usually inaccessible except by some form of portable drill. In case the frame is a heavy one or otherwise difficult to handle the portable drill affords perhaps the best means. The accompanying cut shows the fixture, for a radial-drill spindle, to drill a 9/16-inch hole from a space of only 7 inches between two flanges. From the same setting the "radial" drills, by jig, a number of other holes in the face of the frame. The flanges are shown in section at *A A*, the total available horizontal distance being 7 inches and the vertical distance 1½ inches. The main features of this fixture are the clamp bracket *B*, the yoke frame *C*, the taper shank *D* and taper sleeve *E* with their connecting bevel gears *F F* and proper bushings. The feed is obtained from the power in-and-out



THE FIXTURE AND THE WORK

traverse on the arm of the drill, the fixture being fastened to the spindle quill at *C* and readily removable. With the aid of this fixture the time of drilling one hole including time for setting and removing fixture is less than 5 minutes, whereas formerly a man with a hand-ratchet drill could easily "spoil" a half hour on this job and often more. The outlay for the fixture is trifling while the saving in time is not less than 75 to 80 per cent.

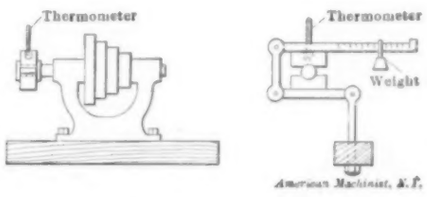
Lowell, Mass. G. H. PERKINS.

An Oil Testing Rig

A copy of your valuable paper came to me a short time ago, and reminded me of old times, when I used to write for the AMERICAN MACHINIST. But some years ago I retired from active work in the machine shop, and now have a small shop of my own where I do a little tinkering just to keep my mind occupied.

Of course, there are many changes and great improvements in labor-saving machinery since I began in the business, 60 years ago, and I love to go over the trade journals and see the changes that have taken place in that time. Yet there may be some kinks that I have come across which will be interesting to the young fellows of today.

An accompanying sketch is of an oil tester I once made when foreman of a railroad shop. Oil salesmen came every week, sometimes oftener, and *their oil* was always best. So I told our superintendent that I would try to "try before you buy." I had an old cone pulley in a frame and on a journal on one end I put a pair of brasses, as per sketch. In the top brass I drilled a hole for a thermometer bulb, leaving about ¼ inch of metal around the journal.



AN OIL TESTING RIG

To get a standard to test the oil by was the next thing. So I got some pure tallow, first took the temperature of the bearing by the thermometer, speed of shaft, number on lever where weight was located, took my watch and started the shaft rotating. I noted on paper the time, speed and weight, or pressure—you will note the rig gave an equal pressure above and below—put in a few drops of melted tallow and started the test.

Soon the temperature began to rise; I took a record of how many minutes were required to raise the temperature, say, from 60 degrees to 120 degrees. Next I got some pure lard and used it in the same way. Now, I had two standards, lard and tallow, with the speed and time required to raise the temperature from 60 to 120 degrees. The oil that came nearest these tests we found to be the best lubricant, provided the oil furnished was equal to sample; often it was like watered milk. The machine was very simple, yet effective.

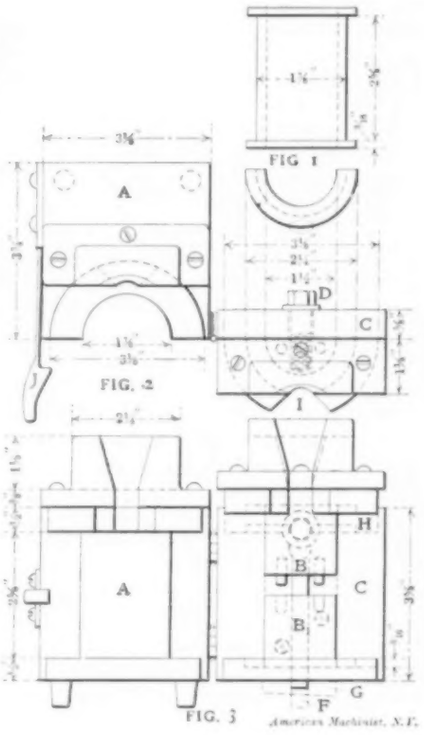
J. J. BINGLEY.

Hanover, Penn.

A Mold for Making Babbitt Bearings

The accompanying line cut is of a mold in which to make babbitt bearings that was designed with the view of doing away entirely with machine work on small engine bearings of which a great number were used. Fig. 1 shows the bearing and Figs. 2 and 3 the mold.

The piece *A* in Fig. 2 is cast iron, bored



MOLD FOR MAKING BABBITT BEARINGS

out in the lathe, then counterbored and faced off from each side on a mandrel. The metal on one side was then planed away to the center of the hole and the remaining sides also trued up. *C* is a piece of machinery steel slotted for collar screw *D* and hinged with common butt hinges, to *A*. Fastened securely to this piece *C* is piece B_1, while the similar piece *B* slides up and down and is guided by collar screw *D* and rod *F*. This rod serves also as a leg for the mold to stand on.

Pieces *B* and B_1 were made together, from one piece of machinery steel that was turned in the lathe and left long enough to allow for sawing in the center and still finish the desired length. Before sawing it was planed down to its axis so as to leave it a true semi-circle.

In order to make the two halves match properly and yet have the mold part properly a V-shaped notch *I* had to be cut out of the flange and a similar V-shaped piece to meet it was fastened between *A* and *B*; the dowel pins which secured this are not shown.

Dotted lines *H*, *F* and *G* show the position of *B* when ready to pour. This up-

and-down movement of *B* is needed to allow for getting the casting out. The mold is shown open, but when ready to pour the right-hand half is swung into position and is clasped by the spring latch *J*.

I might add that this mold was not only quick to operate, but being accurately made the bearings from it were so close to size that only a little scraping was required on them after the runner was removed.

W. J. THOMPSON.

West Toronto, Ont.

A Simple Hand Nurling Tool

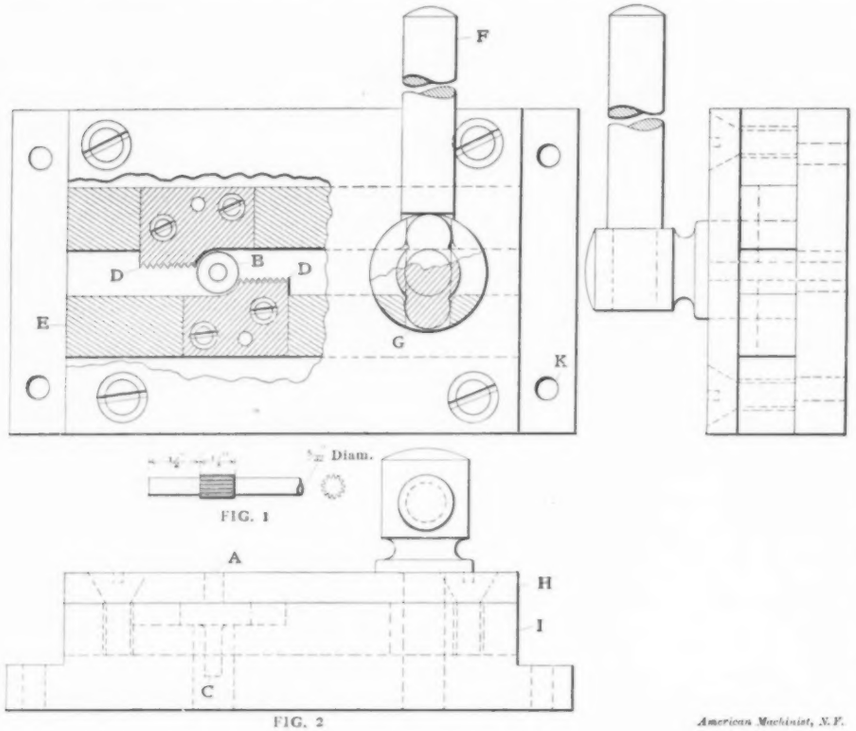
We had a large number of small rods to be nurled, and in order to accomplish this work rapidly and with small expense, the hand-nurling tool shown in the cut was designed. While this tool was used on brass rods, its operation is the same on other materials.

Fig. 1 shows the part to be nurled. The operation was an easy and simple one, and we found that very satisfactory results could be obtained with an output of 25 to 35 per minute.

The work to be nurled was inserted in hole *A*, through the bushing *B* up against the stop *C*. The nurling tools *D*, made of tool steel hardened, were fastened to the sliding parts *E*, made of machine steel, by two screws and a dowel pin. The necessary sliding movement is given to the slides *E* by the cam *G* and the lever *F*, the slides were held down by *H*.

The cheapness of the tool and the ease of its operation made it very satisfactory for the work.

Freeport, Ill. CHARLES EISLER.



THE TOOL AND THE WORK

The Proper Storage of Negatives

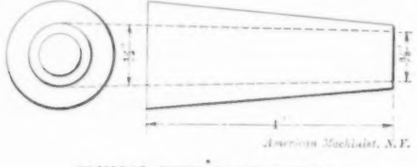
The use of photographs in the selling of machinery is almost universal, and as new machines are brought out the salesman must be promptly supplied with information. This causes a rapid accumulation of negatives, the proper care of which becomes a problem.

With several hundred 8x10 negatives on hand (from any one of which a print may be required at a moment's notice), and new negatives steadily coming in, we solved our problem by devising the case, shown in the cut, which holds twenty 8x10 negatives. The sides, top and front flap are made of heavy cardboard, black cloth covered.

The partitions, which separate the negatives and also absorb any ordinary shock, are of cardboard held in place at the bottom by 1½-inch high spacers, thick

How Can Conical Tubes Be Brazed?

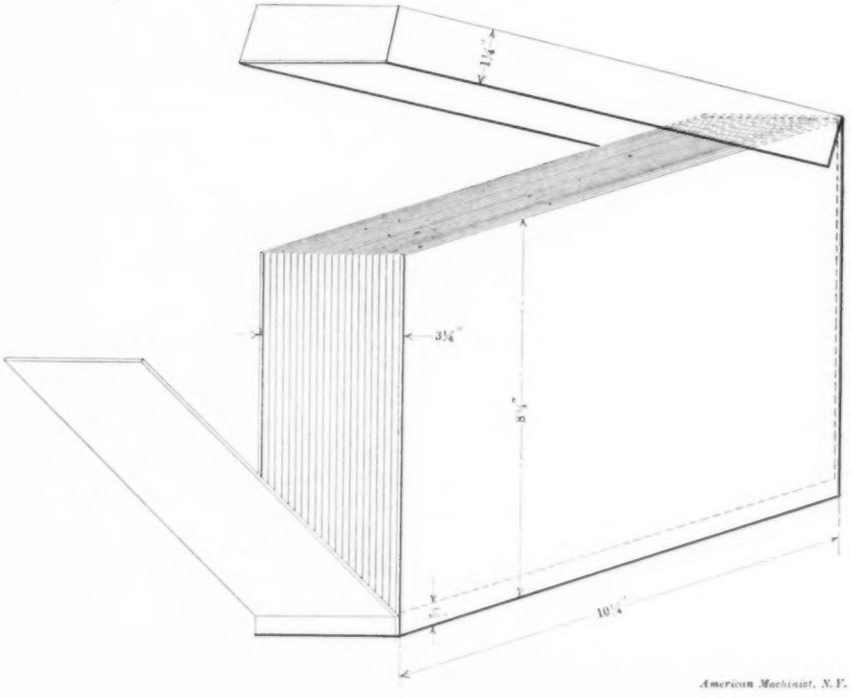
Can any of the readers give through the columns of the AMERICAN MACHINIST a reliable and economical method of brazing a large number of conical copper tubes?



CONICAL TUBE TO BE BRAZED

These tubes, as shown in the line cut, are formed of sheet copper, 4 inches long, with a ½-inch hole in one end and a ⅜-inch hole at the other. The seam where the edges come together must be butt brazed and have a neat appearance.

Scranton, Penn. F. W. BRADY.



CASE FOR STORING NEGATIVES

enough to allow the negatives to slip in easily, the spacers and partition being glued to the bottom of the case, forming a rigid bottom for it.

The hinges for the front flap and for the cover are of cloth. Any box maker will build these at a nominal price. Each negative is numbered and a white label on the front flap indicates the negatives filed in the case.

Neatly labeled and arranged the set of cases are as presentable as a set of well bound books and each negative is instantly available. In cataloging our negatives we give each a serial number as it arrives and also place it under a subjective heading.

Rochester, N. Y. RALPH W. DAVIS.

A Riveting Machine

This machine was built for the Secor Typewriter Company, and has given excellent service. The upright and base are in one casting. The arm and plate *B* guide the spindle *C*, which carries the riveting tool *D*. Ratchet *E* is firmly fastened on spindle *C*, lever *F* engages this ratchet, and as the triple cam *G* impinges on lever *F* the spindle is lifted and spring *H* is compressed, when the cam releases the lever, the spring forces down the spindle and riveting tool to strike the work to be riveted.

As the ratchet *E* is lifted, lever *I* engages the teeth and gives the shaft a rotary motion; this rotary motion changes the position of the riveting tool in relation to the work, which is necessary, as the tool is intended to rivet only a small area at each blow. The spring *H* bears against a ball-bearing thrust collar to avoid torsion of the spring. Lever *J* is used to stop the action of the cam *G*. It is formed like a bell crank and has its fulcrum at a point *K*. The spring *L* tends to force the end of this lever under the lever *F*, but is held out by a treadle attached to the wire *M*. Releasing the treadle allows the lever *J* to hold lever *F* in the position indicated by the dotted line *N* and stops the machine.

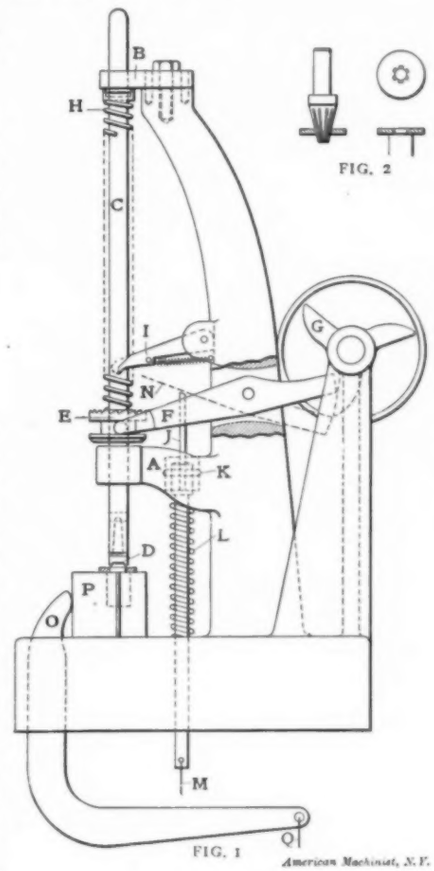


FIG. 2

A RIVETING MACHINE

Lever *O* is used to operate the clamp *P*, which holds the work and is connected to a treadle by the wire *Q*.

Starting and stopping the machine and clamping the work is done by the foot of the operator. This leaves both hands free to assemble the work. The parts to be staked are first broached, as shown in Fig. 2; this allows the metal to take hold in each recess and makes a very strong connection.

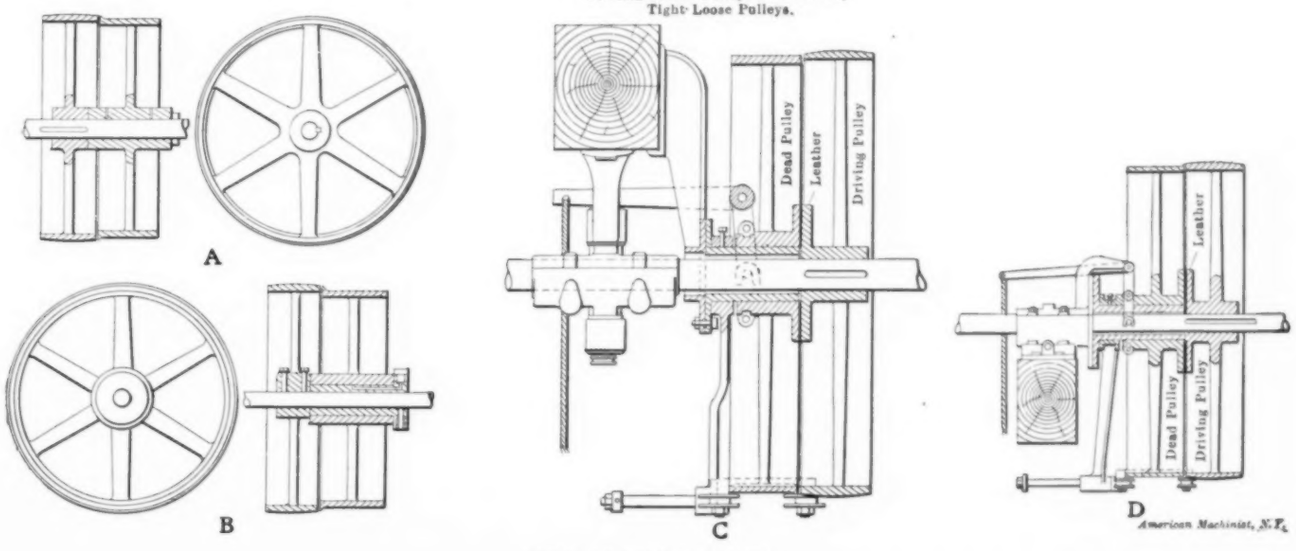
Derby, Conn. F. EBEL.

Tight and Loose Pulleys

So much is being written about tight and loose pulleys that I believe the following will be of interest. Practice will show that the following rules give best results, and should be followed when possible: For belts up to 3 inches wide, with pulleys up to 12 inches diameter—use style *A*. For belts from 3 to 6 inches wide, with pulleys 12 to 24 inches diameter, use style *B*. If no expense is spared to get best results, all tight and loose pulleys should be as per style *B*. For belts from 6 to 12 inches wide, use arrangement as shown at *C* or *D*. *C* shows the arrangement used on overhead lines and *D* shows the same used on lines near the floor. To shift the belt to the driving pulley, on the arrangements *C* and *D*, the loose pulley must first be pressed against the driving pulley by means of the lever and yoke shown, when, owing to friction, both will turn together, allowing the belt to be shifted. From the driving to the loose pulley the belt can be shifted in the ordinary manner. *C* and *D* show the arrangement for the driving end; it is also used on the driven end, but the lever and shifter are then not used. These substitutes for large ordinary tight and loose pulleys have been manufactured by Jones & Laughlin Steel Company for years and have always given perfect satisfaction. For belts wider than 12 inches, a friction-clutch pulley should be used.

AUGUST W. WACKERMAN.

Pittsburg, Penn.



TIGHT AND LOOSE PULLIES

Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Making a Well Shaped Hand Hammer

An article under the above heading, on page 565, attracted my attention. I have at odd times tried my hand at making hand hammers, but have allowed those who were to use them to be the judges of their shape and quality.

What Mr. Thoms says about mechanics preferring a hand-forged hammer to the factory-made article is perfectly true. Hammers that are drop-forged are, as a rule, poorly proportioned, especially around the eye, the sides of which are often much heavier than need be, and the material of which they are made may not be as good as a blacksmith would select for the same purpose. But it is a pretty big claim for anyone to say that they will proceed to "build" (forge, I presume) a hammer that will outlast 10 factory-made ones, especially when the recommended method of hardening is taken into consideration. Just a word about hardening before proceeding further. It is a well known fact that carbon steel, and that is the kind as I understand that is always used for hammers, will not harden to give good service or satisfaction if it is quenched at a temperature under or over the point of recalescence, or when it has been overheated and quenched when the temperature is lowering. This would surely be the case in hardening a hammer when the face and peen are to be hardened at the same heat, leaving the eye soft.

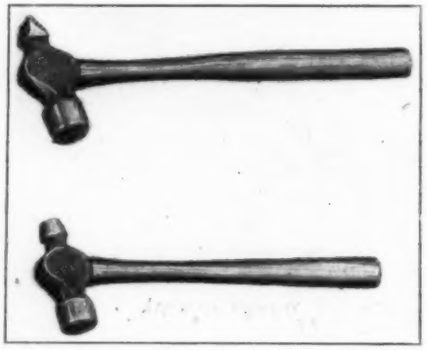


FIG. 9. TWO HAMMERS

But to get back to the subject of making a well shaped hammer: It will be found to be rather a difficult undertaking to work to the dimensions given by Mr. Thoms and make a hammer that would not resemble a pickaxe. The width of the eye is given as 2 inches which is the same as a 1-inch radius. The necks each side of the eye are given at the same radius, meaning that 2-inch fullers would have to be used to bring the sections to the specified sizes, 13/16 and 1½ inches, in accordance with Figs. 8 and 9 in the article referred to. This would make a hammer, if the other dimensions were followed, approximately 6 inches in length and almost as much over 2 pounds in weight as the gain that was made by T. Toot when he made steel grow 50 per cent. by drawing it under a 800-pound steam hammer. Mr. Thoms objects to flat-sided eyes; in that respect I am with him, but they are no worse than the gothic style shown in his article which he says is written for young heads as well as old. This is probably the reason that my head (which is about middle aged) is too dense to absorb the information that no doubt is valuable when understood. When I have occasion to make a hammer a fairly good grade of carbon steel is selected either of round or octagon section slightly larger than the diameter of the finished face. If either of those shapes cannot be conveniently had a piece of larger dimensions is drawn to the required size and enough of it flattened for the eye. The portion for the peen is then drawn down to a little over

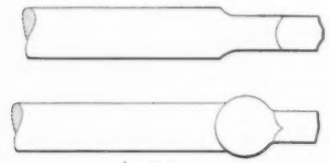


FIG. 1

FIG. 2 FIG. 3

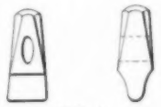


FIG. 4

FIG. 5

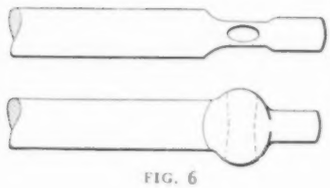


FIG. 6

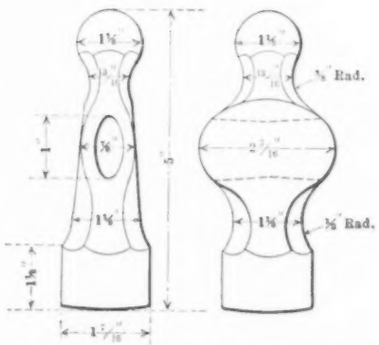


FIG. 7. Approx. Weight with Handle, 2 Lbs.

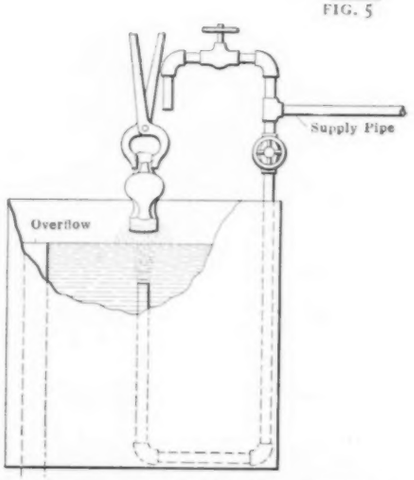


FIG. 8. Approved Method of Hardening Hammers
American Machinist, N.Y.

MAKING A WELL SHAPED HAMMER

the finished size, as shown in Fig. 1, after which an oval-shaped punch at an angle of about 45 degrees from the handle, as shown in Fig. 2, is used to punch the eye.

The punch being at an angle from the handle allows of its being used without getting the hand that guides it any farther from the body than is comfortable, and at the same time permits of the smith getting far enough from the work to see if it is being driven straight. Light blows from the sledge hammer delivered in quick succession are more effective than heavy ones, as the punch is not so liable to bend or upset on the end.

A little green coal placed in the hole prevents the punch heating and spreading and forms enough gas to remove it without trouble. When the eye is punched clear through it is drifted to size, the sides spread and thinned upon an oval-shaped taper drift pin, as shown in Fig. 3. It is preferable to use two drift pins when making hammers, one for the rough part of the work and the other for finishing, as the one that is used while the eye is being spread on the sides gets heated and draws more or less, leaving it in bad shape for neat work in finishing which is essential in a well shaped hammer. The tools for spreading the sides of the eye are a cross-fuller and convex-faced anvil tool, as shown in Figs. 4 and 5. Finishing is done with a plain anvil stake and set hammer, both with the edges well rounded.

When an anvil with a countersunk hole is used the hollow-topped bolster (that Mr. Thoms says can be made from a 1½-inch hexagon nut) may be dispensed with as the anvil will not mark the round edges of the eye, nor are they so likely to be upset as with the bolster. After the eye is finished, as shown in Fig. 6, the necks each side of it are fullered to octagon sections by using fullers for the rougher part of the work considerably smaller than those used for finishing. Hammers to weigh approximately 2 pounds when finished and fitted with a handle can be made from 1½-inch round or octagon steel. In this size the neck between the eye and the peen should be roughed out with ¾-inch and finished with ¾-inch fullers, while the neck between the face and the eye, which is much heavier, should be roughed out with ¾-inch and finished with 1-inch fullers. The peen may be finished cross or ball shaped to suit the ideas of the maker, or the man who is to use it. In finishing the face it is preferable to make it slightly convex, the edges well rounded, not chamfered, and just a little less in diameter than it is at the shoulder where it joins the neck, as shown in Fig. 1, which also gives dimensions that may be somewhat of a help to those who have not had experience in making hammers. The water finish recommended by Mr. Thoms is not necessary to clean tool steel that has been carefully heated. When high-carbon steel is heated to the extent of raising a scale that calls for water to remove it, especially when a forging is nearing completion is a sure sign that the smith has something to learn about steel working. When a hammer is complete as a forging it should be annealed to relieve the strains set up in the various operations and to put it in a condition for easy filing which is necessary to even up the edges, remove tool marks, etc. A bastard file is all that is necessary for the purpose as hammers are tools that are seldom used for work that calls for a high polish, balance and general outlines being more important. One of the best methods of hardening hammers is to heat the peen first to the proper temperature, dip it to about the center of the ball, moving it around in the bath until it is cold enough to carry water, polish and draw the temper with back heat until the color begins to show purple before it is completely cooled off. The face is next heated in the same manner, but should be quenched in a stream of water rising straight from the bottom of the bath, as shown in Fig. 8.

The stream should have sufficient pressure to raise the water directly over it, 1 inch or more above the level of the surrounding water, so that it will strike the center with sufficient force to prevent a cushion of steam forming and at the same time insure the center being as hard, if not harder, than the edges, just the reverse of conditions when quenched in the ordinary manner. After the face is perfectly cold it should be brightened with an emery stick and the temper drawn in a hot, well charred fire until the edges are blue, leaving the center just as hard as possible, as there is no danger of its chipping, however hard it is used when it is supported on all sides by the softer edges. Mr. Thoms refers to the time taken to make a hammer ready for use after annealing and the unequal strains that a hard worked hand hammer has to withstand. What constitutes a hard worked hammer is not very definite. The strains are probably the result of his method of hardening which is likely to leave the center much softer than the edges. In time the center will wear hollow, or it may be upset enough to throw a strain upon the edges causing them to crack or chip.

In regard to the time necessary, any blacksmith who has had much experience in working steel ought to be able to make a first-class hammer complete, well inside of two hours. Fig. 9 is a half-tone of two types of hand hammers which are generally considered fairly well shaped with the exception of the ball peen which was made for special work. Both of those hammers were made complete in a little over 1½ hours each, not including the time they were being annealed.

Plainfield, N. J. JAMES CRAN.

Drawing an Ellipse with Compasses

Referring to an article by F. L. S. in the AMERICAN MACHINIST page 428, on "Drawing an Ellipse with Compasses:"

I have found in practice that one can get over the third point difficulty in a somewhat simpler and more expeditious manner by taking half the major axis as a radius and then proceed as already described in article. The position of the center has still to be found by trial, but one has the radius straight away.

Cambridge, England. E. E. P.

Ways of Getting Jobs

The articles published in your paper on the above subject have brought to my mind two cases which were alike novel, amusing and successful. Both occurred in engineering shops, though one was in England and the other in the United States.

In the first case Smith was hard up for a job, and one day met an old chum and told him of his trouble. "Well," said the chum, "you must come down to our shop; we are fairly busy just now." The chum went on his way and thought no more about the incident; but not so with Smith. The next Monday morning he was at the works in good time and, without a word to anyone, got a barrow and commenced to wheel out turnings and chips from the machine shop. When he had been thus occupied for about an hour the boss came along and seeing the new man inquired, "What are you doing here? Who told you to start work?" "Mr. J—— told me to come, sir," was the reply. "Indeed! Well, just wait a minute." The boss went to J——. "Look here," he said, "this fellow says you told him to start at work." "No, sir; I did not," replied J——. "I told him to come down, but I meant him to come and see you." "H'm"—the boss thoughtfully rubbed his chin—"you don't seem to have made your meaning clear," he said. "But anyhow you can go on," turning to Smith, "I dare say we can do with another man."

The other case was of a similar nature. Brown was a man of the laboring class and was wanting a job. After an interview with a friend who was fortunate enough to be employed as laborer in a large shop, they arrived at a definite conclusion. The result was that the next day Brown went with his friend to the shop and started to help him sweep the floor. The manager noticed him after awhile, and going up to him inquired, "Who told you to start work?" "That man over there," was the reply. "Here, Jones," cried the manager, "what's this about?" "Oh," said Jones, "I had more work than I could do, so I told him to come in and help me." "Well! That's the

d——," exclaimed the manager. Then he went into the office and finished up by giving Brown a proper start.

Here are two fellows who would take some beating, and I think all will agree that however "black" trade is looking, the men who, like Smith and Brown, are determined to get on, will get work as long as there is work to be had.

Shipley, England. S. C. RIPLEY.

"Expert Witnesses"

I read E. A. Dixie's article on page 493, on the above subjest, and it recalled an incident which happened during an inquest in the Belfast courts a few days ago. A solicitor was cross-examining a witness in reference to some wire connected with the machinery where the fatality occurred.

"You're an expert witness aren't you?" said the solicitor.

"Maybe I am and maybe I'm not, was the quick reply, but I'm not an expert wire-puller anyway."

"Then someone whispered—"He isn't a member of the City Council," and the "expert" wondered what caused the laughter which followed.

Belfast, Ireland. TERRY.

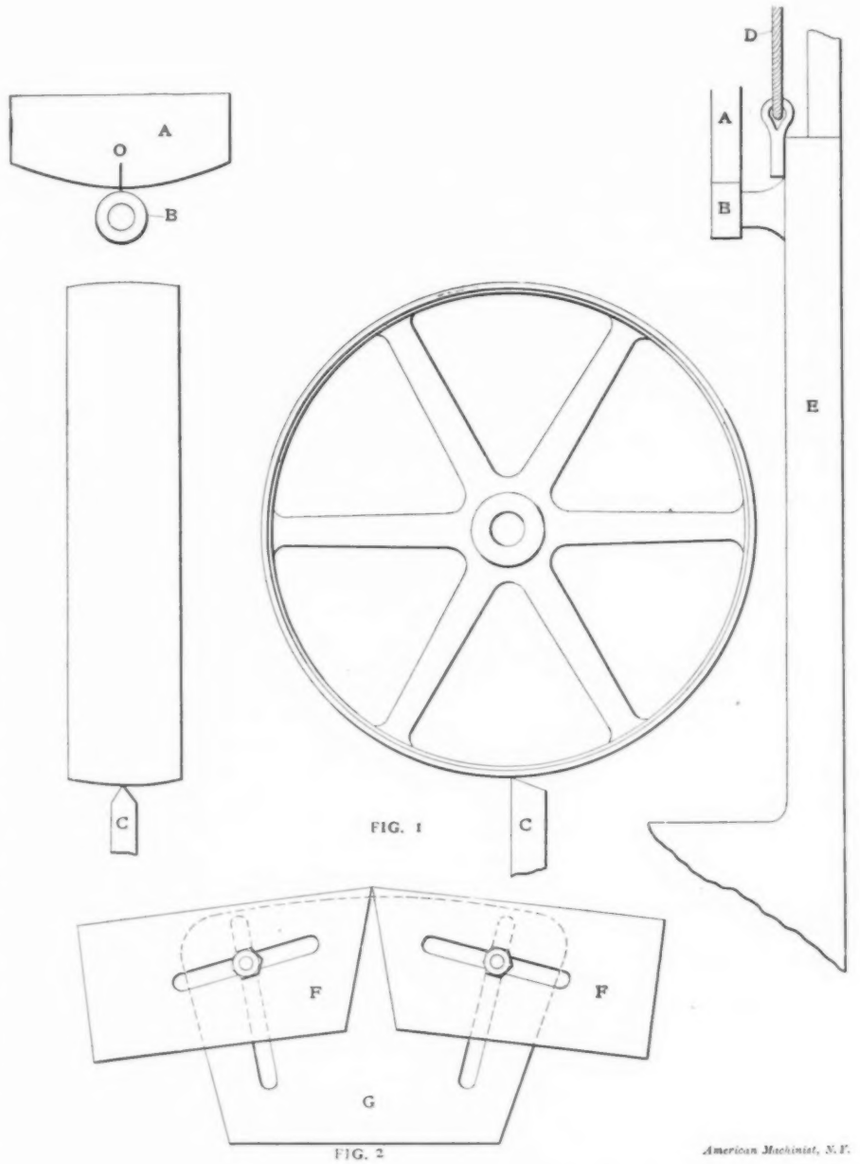
Grinding Sleeves Internally

At page 528, U. S. Garde shows a method of chucking long chambered sleeves for grinding internally. To do this he prepares a cast-iron bush bored to fit the sleeve and fitted with a set screw to grip the sleeve, then chucks it true on the grinding machine. The sleeve supported in the bush is gripped by the set screw at one end, the other end being supported in a steady rest. He states that the bushes pay for themselves if there are only a half a dozen sleeves to grind. I wish to take exception to this statement. First, the cost of the bush will more than exceed the cost of internally grinding half a dozen sleeves if the operator understands his work. A skilful grinder will be a skilful setter-up. A man doing internal grinding will not spend on an average more than a minute in setting such a job true within 0.0005 inch, which, if the portion of the hole to be ground out is 1½ inches long and the sleeve 12 inches long would entail an error of only 0.00006 inch. As a rule, an ordinary self-centering chuck would be used and errors in the chuck counteracted by pieces of cigarette paper (which, I believe, is the thinnest paper available), placed between the jaws and the work. The better way, if any way is really needed better than chucking by trial, would be to use a conical split chuck or collet, which is a really serviceable tool suitable for any job that may come along.

London, England. A. B. TRASK.

Crowning Pulleys in the Engine Lathe

Beginning with an article by E. W. H., on page 393, there has been considerable said upon this subject. I show herewith in Figs. 1 and 2, a simple device which I had occasion to make some years ago in the shop. The idea was not original except in Fig. 2, but as I have forgotten whom I stole it from I am afraid I cannot give credit. *A* is the former which is secured upon a suitable bracket attached to the back of the lathe bed. *B* is a roller which follows the former and is attached to a stud fastened in the cross slide *E* of the lathe. The tool *C* is secured in the tool post and the compound rest is set at right angles to the bed so as to permit feeding in or out as may be required. A hook is secured to the end of the cross slide *E* and to this is fastened a rope *D* which passes over a pulley and is secured to a heavy weight at the back, the object being to keep the roller *B* in contact with the former *A*. In action the cross-slide screw is removed. The roller *B* is set to the line marked *O*, which is the center of the arc. The tool *C* is then set central with the face of the pulley. The compound rest is run back and the tool is moved to the edge of the pulley, set into cutting depth and the feed thrown in. It is obvious that the tool will travel in the arc of a circle the same as that followed by the roller *B*. For straight crowning I devised the former shown in Fig. 2, which consists of two plates *F* secured by bolts to a third plate *G*. With this device any angle of crowning within very wide limits can be obtained. By using a suitable former, mounted like Fig. 1, such work as machine handles can be readily turned in duplicate.



CROWNING PULLEYS ON THE ENGINE LATHE

New York. E. A. DIXIE.

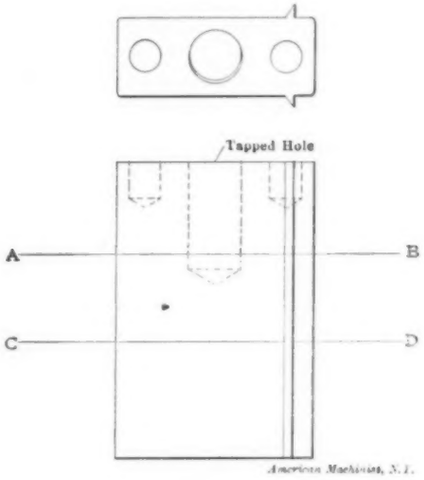
Objection to Heating Tools in Lead Bath

In his excellent article on "Hardening Methods" Mr. Scott says, on page 695, Vol. 32, that "he has not been able to discover any good reason why steel should not be heated in lead."

I have been in trouble more than once with die sections and punches that have been heated (for hardening) in the lead bath and would be glad if Mr. Scott would show how the trouble is to be obviated.

The sketch shows a punch commonly used in built-up armature lamination dies. The die sections are about the same length and weight, and are hardened in the same manner, therefore, the argument will apply with equal force to them.

The dowel pin holes are drilled in these punches after hardening, so it is desirable to keep the back end in its annealed con-



PUNCH HARDENED BY HEATING IN LEAD BATH

dition if possible. They are often heated in the lead bath for this very reason, being immersed in the lead to the line *A B*, and brought to a hardening temperature as high as the line *C D*, about ¾ inch up from the face.

I have invariably found that punches heated in the lead bath and hardened in this manner shrunk considerably in thickness and width at the punch face, and thickened about the line *C D*. I remember one set of punches which shrunk 0.002 inch at the face and thickened so much in the middle that they presented a barrel like appearance to the eye, and caused much inconvenience in assembling the die.

The reason for this is obvious. The punch is immersed in the lead up to the line *A B* and the exposed surface above this line conducts away so much heat (radiating some) that before the region around *C D* is at the hardening temperature the face of punch is much too hot. This inequality of temperature is increased, the less the length of the punch, and the greater the area of the face. Thus the face of the punch shrinks because it is too hot, and the middle expands because it is not up to full hardening temperature.

I do not know any remedy. Perhaps Mr. Scott will say, immerse completely. But I would point out that this defeats the very object of using the lead bath; the pieces might as well be heated in a furnace. Moreover, I have generally found the lead bath in use for local heating, and by analogy should expect the same results on other classes of work.

Brooklyn, N. Y. F. J. B.

High and Low Carbon Steel for Tools

My article on page 222 caused considerable discussion among steel workers and makers. One point to receive special attention was the recommendation of 1.65 per cent. carbon steel for purposes where great strength and hardness are required instead of the usual grades containing from 0.90 to 1 per cent. carbon. Was there any room for a joke here? Although no mention was made that a steel higher in carbon than used for razors would be suitable for such shock-enduring tools as cold chisels, some enthusiasts did try out the trick for curiosity's sake, and I was one of them.

One man who made a cold chisel out of steel showing a crystal hardness of 0.65 by the scleroscope and, according to the scleroscope test contained 1.65 per cent. carbon, reported the result as follows: "I forged the chisel at a good red heat and then, using a flat hammer hit it a few blows while at a very dark red, for the finishing touches; hardened it at a point slightly above the non-magnetic, and drew the temper to a straw yellow, and sharpened well. I put an ordinary cold chisel in the vise with the point up and began to test the new one by trying to take a slice out of it. To my astonishment I succeeded without spoiling the edge, save for the usual change over to a regular cold-chisel edge, as against a wood-chisel one. Not regarding this test as a fair one, I reground it sharp enough to cut wood or paper and then used it all day on tool steel. Few chisels will stand up on this work when unannealed."

This chisel was loaned to me and measured 104 hard after drawing the temper, thus indicating that the initial hardness must have been very near 110. The tool seemed simply indestructible on even unannealed steel (55 hard), which contained 1.70 per cent. carbon. I also made some chisels of 1.65 carbon steel, treated them exactly the same way and these showed the same incredible efficiency. Both steels had the property of hardening up to 110, which indicated that they were pure and all the carbon was available.

Years of practice in the new tool-working science made possible by the guidance of accurate hardness testing has shown that even in the lower-carbon steels there are possibilities which are practically untried except by accident. With the introduction of precision methods, involving the selection of steel that is of really good, if low-carbon stock, changes almost amounting to a revolution, in practice, have resulted in many establishments, both in this country and in Europe, even in Japan.

While low-carbon steels have limited power particularly to resist wear it is often possible to get real strength and performances, which are, indeed, excellent. These steels are, as a rule, more difficult to handle than the higher carbon for the reason that their strength is dependent for the most part on the fiber compression, which is either destroyed during annealing, or by the most trifling overheating. However, many who have to content themselves with the low-carbon steels now on the open market, much of which must be obtainable at very short notice, have begun to cut the number of tools, formerly made, down to one-third, or one-fourth, and with the result that much longer cuts can be taken, or in stamping work the machines can be kept going much longer so that more uniformly accurate sizes can be maintained.

As an example, one firm making rivets and wire nails, found, after many years of experience, that for a certain size rivet (¼ inch in diameter) among others, the dies would stand up, on the average, for about 800 pounds. Occasionally, but rarely, one would stand for 2000 pounds, while others failed often with only 25 pounds. Some dies hardened by the new exact method advocated by me and made of the same ordinary steel, and doing exactly the same work, averaged over 3800 pounds.

In ordinary planing tools used for undercutting or relieving very large gear teeth, as done by the Westinghouse Machine Company, it was formerly possible to thus gouge out something like eight inches of teeth before the tool failed, but after the adoption of the new precision method, 36 inches of teeth could easily be machined.

This effected a saving of three expensive forming tools out of every four, there was no ripping of the teeth by the snipping of the poorer tools; more accurate work would be done, because of the long intervals between the changing of the tool; and a saving of time was effected by not stopping the machine so often. Nothing but a selection of ordinary medium carbon steel is used in this work thus far.

I have on hand other data relating to different kinds of steel treated by precision methods and used on special classes of work which will be discussed later on.

New York, N. Y. ALBERT F. SHORE.

Solders and Fusible Alloys

By H. F. Blake

Solders act under constant stress considerably like plastic or semi-fluid material. Their fluidity resembles that of tar or gum, and their distortion with time is greater than would be thought.

It is surprising to note how many men in this field of work are not acquainted with the chemical ingredients of, and the effects upon, the strength of materials produced by fusible alloys. In a series of tests a notable point brought out was the varying degrees of strength with age; the composition of solder remaining the same. Tensile strength increases with the percentage of tin present, but when the solder's age is considered as a factor, the product possesses its maximum value at 60 per cent. tin, showing this property as similar to that of the melting point and depending upon chemical composition.

For general work, the solder requiring resistance to stress is 60 per cent. tin, but for work requiring little mechanical strength, such as sealing, a lower per cent. of tin may be used and thus the solder rendered available at much lower cost.

Generally speaking, all solders are alloys of lead and tin. The more lead the alloy contains, above 40 per cent., the higher is its melting point, as also the less lead it contains, below 40 per cent., the higher is its melting point.

The melting point of alloys which fuse at a low temperature may be found by tying a small wire around a fragment of alloy and hanging it in a bath of water. A thermometer should be kept in the bath and the temperature increased slowly until the alloy melts. The melting point of the alloy can then be noted by the temperature of the bath. For higher temperature a bath of paraffin or oil is used. If bismuth is added to these alloys the melting point is lower, as bismuth possesses the quality of expanding on cooling, a property which is very unusual in metals. Bismuth is used not only to make the alloy or solder more easily worked, by diminishing its melting point, but if sufficient quantity be present its expansive tendency counterbalances the effects of the contraction of the other metals, and the total result is the prevention or reduction of shrinkage in the mold. The addition of cadmium still farther lowers the melting point of such alloys as those of bismuth, lead and tin, which in themselves have very low melting points.

Hard solders sometimes contain more or less copper. A substantial solder contains 60 per cent. copper, 20 per cent. tin and 20 per cent. zinc, and does not possess any lead. An easily melted yellow, hard solder contains about 45 per cent. copper and 55 per cent. zinc. This solder is really a brass, but at times is used for soldering, binding and filling purposes. Nearly all aluminum solders are alloys of tin and aluminum that contain from 15 to 25 per cent. aluminum. A small per cent. of copper or nickel, never exceeding 2 or 3 per cent., is sometimes used. The exact point of separation between a fusible metal and a nonfusible one is very uncertain, thus several additional alloys are given in the table. In filling up imperfections in ornamental castings for plugs in electrical wiring and on boilers in engineering work, fusible alloys are used. Sometimes defects in structural steel have been filled in with expanding alloy, after being dressed in a coat of paint. The United States Government rules call for pure Banca tin for boiler plugs, but this is not essential and any good tin will serve the purpose.

One of the fusible alloys may be easily used, if a lower melting point is necessary. They are employed as conductors of current, in short lengths in electric circuits, for current interrupters, as they melt as soon as the current becomes too strong. Rose's, D'Arcet's and Wood's alloys all may be used for this purpose, as well as for taking impressions from paper or wood molds. Pewter, type metal and many others manufactured under trade names are fusible alloys of both industrial and commercial bearing, rather than of engineering importance. If the temperature required is not too high, the melting point of an alloy may be determined by fastening it to a string or wire and immersing it in a bath of some material with a high boiling temperature. Many substances are used for this purpose such as paraffin, carbo-hydrates, mercury, and even sulphur; the latter is apt to affect chemically the structure of the alloy by disturbing the chemical proportions and producing sulphides. By adding such metals as arsenic, silicon, or phosphorus to alloys they become fitted for special uses. A vast number of the nonmetals used in alloying have a tendency to make more brittle the material with which they are compounded. Sometimes they affect the variations of its properties with heat, to a marked degree. This is shown in various iron alloys composed of small percentages of impurities and which are used for tool-making purposes.

Quite recently there has arisen an interesting development in the use of fusible metals for fire extinguishers, such as are used for automatic sprinkler devices. These automatic sprinklers have been found to operate very satisfactorily at the temperature given, but they are not sufficiently low to respond to the temperatures which will render their aid satisfactory with minimum loss.

Today practically all the makers of automatic sprinkler devices are attempting to find a fusible metal, or some kind of solder which will have a considerably lower melting point than any possessed by those shown in the table, and at the same time have sufficient tensile strength and resistance to strain with age to prove satisfactory in this field.

Experiments have been made in an engineering college quite recently for the purpose of finding the way of making solder joints, as well as measuring their tensile strength. Any pressure upon the solder at the moment of setting diminishes the strength of the joint. Thus, in making a solder joint, the upper piece should be held above the lower one, the solder fused by means of two blow torches, and the pieces brought together by very slow and easy pressure. By employing this method, which differs from that commonly called "sweating," the joint is less liable to be broken, as the crystalline composition of the resulting mass contains less resistance at this time.

In addition it is found that there is remarkable variation with time of the tensile strength of such joints, which is also in accord with what would be considered proper by engineering science in this field. Under any circumstances the average strength attained does not exceed 27,000 pounds per square inch, and was obtained from solder made with three-fifths of its composition tin.

This accords with the statement farther on, that the addition of tin greatly increases or toughens a joint, and is chiefly

Alloy.	Lead.	Tin.	Bismuth.	Other Constituents.	Melting Point.	
					Cent.	Fahr.
Solder 1	96.15	3.85			292	558
Solder 2	90.9	9.1			283	541
Solder 3	83.3	16.7			266	511
Solder 4	75.0	25.0			250	482
Solder 5	66.7	33.3			227	441
Solder 6	50.0	50.0			188	370
Solder 7	40.0	60.0			168	334
Solder 8	33.3	66.7			171	340
Solder 9	33.3	33.3	33.3		140	284
1. Steam boiler plug	48.4		12.8	Zn. 38.8	171	340
2. Steam boiler plug	44.5		22.2	Zn. 33.3	141	285
3. Steam boiler plug	42.1		42.1	Zn. 15.8	123	253
4. Steam boiler plug	10.0	40.0	50.0		116	240
Sir Isaac Newton's	30.0	20.0	50.0		100	212
Suitable for casts	31.25	18.75	50.0		98	208
Rose's alloy	28.1	21.9	50.0		95	203
D'Arcet's alloy	25.0	25.0	50.0		93	200
Wood's alloy	25.0	12.5	50.0	Cd. 12.5	60	140
Lipowitz's alloy	26.9	12.7	50.0	Cd. 10.4	66	150
Expanding alloy	66.7		8.3	Cd. 25.0	66	150

COMPOSITION AND MELTING POINT OF SOLDERS AND FUSIBLE ALLOYS.

undesirable on account of cost. An interesting point is that the regular time of each test was about 20 seconds, and was worked out with the ordinary testing machines used for such purposes in the average engineering laboratory. In this time of testing a decrease to five seconds would increase the tensile strength to over 30,000 pounds to the square inch, though for all practical purposes such tests are unreliable, since in actual conditions such pressures or tensions, when they exist, usually last for longer intervals.

Solders 6, 7 and 8 in the table are universally used by tinsmiths and plumbers, while 9 is intended for household mendings, as it can be readily melted over any flame and poured upon a leak. The various degrees of melting point where a percentage of lead is present is easily seen from the table.

Fundamental Principles of Industrial Education*

By Herman Schneider†

It is intended to take the size of the problem, the field that the problem covers, and the end to be attained, and then to build synthetically a solution.

The Problem

The problem of education, viewed from the points of industrial progress and the stability of the State, is the training of the mass for efficiency in industrial and civic service. The problem is as big as the United States, because of the interdependence of industrial effort, and because ultimately all education must be framed to strengthen the stability of the nation. In other words, the chief end of education is so to instruct the individual that all individuals as civic units will combine to make the best possible State.

In the United States there are over 18,000,000 children in the public schools; over 17,000,000 of them drop out when the law permits them to, and they go into agricultural, commercial and industrial life. In the industrial centers they go into the factories and stores; but up to the time of leaving school they have not received one iota of industrial training that is worthy of the name. The size of the problem may perhaps be understood more clearly if it is stated in this way: if these 18,000,000 children were stretched across the country in a straight line, giving one linear foot of space to each child, the line would reach from the upper end of Maine to the lower end of California. That portion which goes through the high schools would reach across the State of California. The rest of the line from Maine to the eastern border of California is drawn into commercial, industrial and agricultural life at about the age of 15 years, with no industrial training prior to going to work and practically no schooling thereafter. This proportion holds in any industrial town or city.

Scope of the Problem

The writer has heard many discussions on industrial education and has read many papers by very able writers. In almost every case the discussion has been contributed by the members of a society that represents a particular branch of industry, or the paper has been written by a man who feels that the trade with which he is most familiar is the most important of all. Members of the American Institute of Electrical Engineers, for instance, in discussing this problem, would usually not consider the educational situation from the point of view of the master tailor, the telephone company superintendent, the head of a department store, the pottery owner, or the building contractor. Investigation on this subject, covering a period of 9 years, discloses the curious fact that a man in almost any business considers the art of his trade as more difficult than the art of any other trade, and he inevitably insists that there must be trade schools to teach the children that go into his particular field of work. He is insisting at present that the public schools shall include specific training for his trade; and there is a general clamor from individuals and societies representing certain industries for the introduction of training in their particular trades into the public-school system. Consider for a moment what this means.

If you take the industrial directory at the end of any city telephone book, and attempt to make a list of the trades therein shown, you will find, in a town like Cincinnati, that when you get to the letter E, you have almost 100 distinct trades. The proposition of putting equipment into the public-school system of Cincinnati to train the children for all the different trades in Cincinnati would make so top-heavy an organization, and necessitate so many buildings, that the imagination is staggered. Further, in many lines of industrial work the machinery becomes obsolete about every 7 years; if, then, the trades are to be properly taught in the schools, the equipment for the whole system must be changed at least once in 10 years. The advocates of trade instruction in the public-school system evade these very essential facts by saying that the more important trades only should be taught. There are two phases to this latter proposition:

1. Who shall decide which are the more important trades? And how shall public support be obtained from all sources for these few trades?

2. Are the children to be taught a few trades, leaving all the other trades neglected, and leaving the predilections of the children out of question entirely? Or will only a few be trained in the more important trades, and the rest be allowed to shift for themselves as heretofore?

Should this be attempted, it would simply be a partial solution, and a very small one at that, of the whole problem of industrial education. If, for instance, we teach in the public schools the plumbing, machinist, wood-working, and molding trades, what would be the solution for all the children entering the numerous other trades and commercial occupations?

There is, further, the taxpayer to take into consideration. Let us assume that you and I are residents of the same town, in moderate circumstances, and paying about the same amount of taxes. You have a boy and a girl and I have a boy and a girl. Your boy desires to be a machinist, and the public schools will take care of him; your girl desires to be a stenographer, and the public schools will probably take care of her. My boy wants to be a printer. Have I not the same right to demand that the public schools shall teach my son to be a printer, as you have that they teach your son to be a machinist? Shall the public-school system say to my boy: you have got to be a machinist, plumber, molder or wood worker, or go without a trade training! My girl wants to be a telephone exchange operator. Will you tell her that she has got to learn her work without any training? Is it fair for the owner of the machine shop to tell the telephone company that it must train its own help, when he demands that the public schools train his help?

In view of the foregoing, it should be obvious that any attempt to put trade schools, that is, schools that teach trades, into the public-school system, would result in a tremendous expenditure of money for skilled teachers and for equipment which is not commercially productive. Any attempt to put in a few of the trades would afford only a slight solution of the question. The big problem would still be before us.

The Situation

The size of the problem, and its scope, cause us to be confronted by a peculiar situation. In the first place the problem is so comprehensive that there is probably only one organized institution capable of carrying it; namely, the public-school system. It ought not to need any argument to prove that private enterprise cannot furnish the solution when an average city has 10,000 to 20,000 children to be educated every year, if they are to have industrial education. Figures are available, if they are necessary, to show the futility of private endeavor in industrial education. In the second place, to install a series of trade schools in the public schools is impossible, because of the expense and the inevitable complications.

Let us take account of stock. Every industrial center has a group of school buildings with its quotas of trained teachers. It also has many factories and

*A paper read before the American Institute of Electrical Engineers.

†Dean of the College of Engineering, University of Cincinnati.

commercial houses. Under present conditions most of the children who leave the public schools go at once into the industries or stores, and there is no connection whatever between school and shop. The children go to work not because they want to, but because they have to become little bread-winners. Here, then, are many children working in some capacity, and a series of public schools carried on only for those who are fortunate enough to be able to continue in their school work. Since the public-school system is the only organized institution capable of dealing with all these children at work, and since the children are also learning a trade and earning money sufficient for their simple wants, it seems that the only complete solution of the problem is a system of cooperation between the schools and the factories for efficiency training and civic training of the young people after they have found their work.

How, then, can this coöperation be built up within the limits of reasonable economy? Fortunately, there are three or four experiments going on which indicate that a coöperative system is feasible in the trades, as it has been shown to be in engineering training. Several of these will be briefly described to indicate the various methods of solution.

The Coöperative System

The fundamental principle of the cooperative system is very simple. It is this: the technique or the practical side of the work is taught only in a shop or store which is working under actual commercial conditions, and the science underlying the technique can be taught properly only by skilled teachers. All questions as to who shall supply the school teachers (the shop or the public); the hours the student works, and the hours he is taught; the periods of alternation of shop and school work, if alternating periods be used; and the curricula of the schools—all these are matters of detail to be considered for each particular case.

The economy of the system is at once apparent. In an engineering school, for instance, twice the number of students can be taught at about two-thirds the expense as compared with the four-year theoretical system. The same is probably true in industrial education, for under the coöperative plan the schools will not require any physical equipment; all their money can be used for brains and for buildings for teaching purposes only. There is a further economy to the student. In this case he is earning while he is learning, while under the trade-school system he does not earn until he has completed his trade education. Parenthetically it should be stated that no displacement of the present high-school courses is contemplated.

At Fitchburg, Mass., the coöperative system is a part of the public-school system. The students are divided into two groups which alternate every week. That is to say, this week one-half of the students are in the day school and one-half are in the factories. Next Monday morning these groups will change, and those who are in the school this week will go to the shops, and those who are in the shops this week will go to the school. Since the public school becomes a part of the apprenticeship system, it has a voice in the organization of the apprentice course in the shop, and is in *loco parentis* to the boy, so far as his shop work is concerned. It ought to be obvious that the boy will receive a fair training in the shop because the school is in a measure watching over this phase of his work.

It is not intended, of course, that this plan should apply only to factories. It will apply to a boy learning the tailor trade, the butcher trade, the baker trade, or any other trade. It is necessary, however, to obtain two boys to alternate in the shops.

The course in Fitchburg is of five years' duration. At the end of that time the student has been taught the simple science underlying his trade; he has been taught shop mathematics; he has been given a certain amount of cultural work; he has become a fair mechanic. In brief, he is at the beginning of specialization.

It has been found further that the money earned every alternate week, and for full time during the summer, is sufficient to pay for the simple wants of these children. It is also true that there is seldom an instance when a child is hindered by financial conditions from taking such a course.

A number of changes in the system of administration have been found necessary, and these details will be considered to show certain phases of the working of the system. In the first place, the grade-school principal is responsible to the school authorities for every boy in his district. When the boy leaves school at the legal age, the grade-school principal is required to follow him and ascertain what he is doing. He then consults the parents of the boy and the boy's employer, and the question of the future of the boy is immediately shifted to them. The employer is urged to enter into a combination with the school in the effort to make the boy more efficient at his work, and to give him a little more general education than he would otherwise obtain. The fact is impressed upon the young man and his parents that he ought to make a choice of a trade for life, if possible. If it is found after he has begun work that he has no aptitude for that which he has undertaken, an attempt is made on the part of the school principal, the parents, and the employer of the boy to find the kind of work for which he is best fitted. As some one has expressed it:

Under the coöperative public-school system, the grade-school principal pays much less attention to biology and much more to the boy.

Shop Coördination

The second feature is the work of shop coördination. In order to explain this, the method of operation in the Engineering College at the University of Cincinnati will be used as an example.* The coöperative engineering course at the University of Cincinnati is of six years' duration. There are, therefore, six classes, and there is one shop coördinator for each class. The shop coördinator is a college graduate acquainted with shop practice. He spends every morning at the university and every afternoon in the shops. His function is to make a direct weekly coördination of the work of the shop with the technical work of the university. This afternoon, for instance, he may be at the shops of a local manufacturing company, where he will observe the student apprentices at their work. He will know what they are turning out, their "speeds, feeds and cuts," the angle of the tool, how the batch of work is "ticketed," how the work is set up, the power drive—everything important in connection with the operation. Next week these young men will be grouped together with their classmates for two periods in class, when he will explain the functions of the particular articles on which the students were working in the machine which the local manufacturing company builds.

He will take up all questions of speeds, feeds, cuts, accuracy, etc.; figuratively speaking, he will take from the student apprentices the blinders which would restrict their vision except for this explanatory work. The "ticketing" of the batch of work is gone into, the system of shop routing is explained. Ultimately, all problems of shop organization, shop accounting, cost keeping, shop planning, power transmission, heating, ventilating, lighting, etc., are discussed during the six years' course. In conjunction with this, a card system is employed, by means of which everything the student does in the shop that exemplifies a theory taught in the university is called in detail to the attention of the teacher of the theory, so that when the student comes to that particular theory the exemplifications which he has had in his practical work in the shop are called to his attention. It will be seen, then, that out of the student's own experience is drawn much of his course in mechanisms, thermodynamics, machine design, strength of materials, etc.

In the coöperative work in the public schools this close and immediate tie is taken up in a modified way. There will be a shop coördinator for such trades as have a fairly close relationship, rather than by classes, as in the university.

An Application of the Principle

Now in order to show the application of the fundamental principle of the cooperative system mentioned above, but

*This feature is just being introduced and its effectiveness cannot be stated at the present time.

with a deviation in detail to meet a special condition, let us consider the department store. Such a course has been devised and is about to be put in operation. The fundamental principle is strictly held to, but the details are modified to suit the conditions. In any department store the clerks are not usually busy until 10 o'clock in the morning. A store can get along easily with one-half its clerks from 8 until 10 o'clock. It is intended to divide the force in two sections, one-half of whom will receive instruction this week from 8 until 10 o'clock, while the other section is working; the following week the sections will be changed about. In this particular instance the students do not go to the public schools; the teachers go to the store. It is evident that it is easier to transport 20 teachers than to transport a large number of student clerks. A number of rooms in the store, such as carpet rooms and lace rooms, are set aside during these two hours for the class work, the chairs being removed at 10 o'clock, and sufficient space being reserved for any business which may be necessary up to that time.

It is contended by department-store owners that salesmen should know the psychology of salesmanship, and have a fairly expert knowledge of the things they are selling. They should receive, besides, a certain amount of general education. The psychology and the general education are to be taught by trained teachers from the public-school system. In order to teach the practical end, the following method has been adopted: Consider, for instance, the shoe department. If one pair of shoes costs $1.85, and another pair costs $1.95, the salesman should know where the difference of 10 cents' value lies. Let us assume that this particular department store buys shoes from a firm in Brockton, Mass. When it makes its next contract for shoes, it will insist that the firm selling the shoes send an expert demonstrator to its store to explain in detail all the successive operations in shoe making and all the different elements which make differences in cost. The tanning firm from which the shoe manufacturer buys its leather will be required to send to the store an expert to exemplify practically to the students the different grades of leather in a hide, methods of preparation, and why one kind of leather is used in one part of a shoe and another in another part of a shoe. It has been found that the shoe manufacturers will very gladly enter into any scheme of this sort. He would, in fact, be a very short-sighted manufacturer who would not. This same general idea is followed in all of the other departments, such as jewelry, linen, silk, furniture, etc.

Other instances might be cited of experiments now in operation based on the simple principle of the coöperative system, with changes in detail, but the scope of this paper will not permit their consideration here.

It is intended to call particular attention to the fact that under this plan the public school deals with the whole general problem, deals with it without physical equipment. It is, in other words, a return to the old apprenticeship system with something added; namely, definite instruction in efficiency by trained teachers, and additional instruction aiming toward better citizenship.

Alternating of Students Leads to no Demoralization

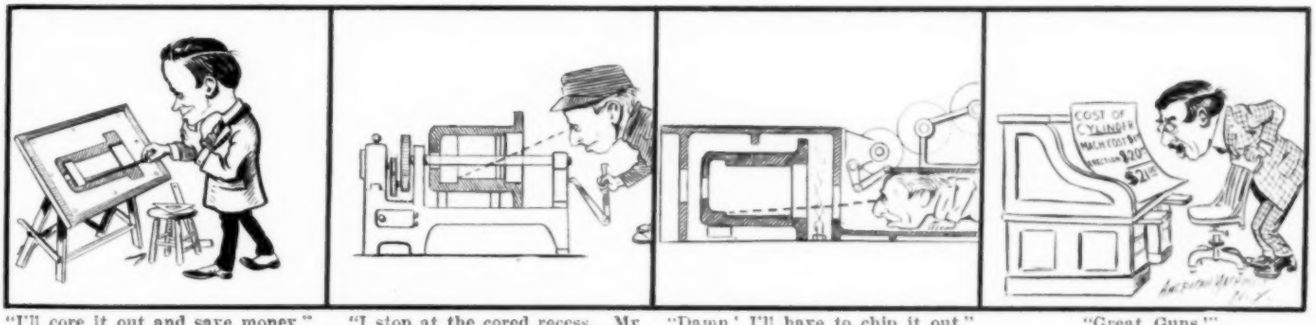
The writer realizes that many manufacturers will say that a scheme which brings two sets of students into any work on alternate weeks—assuming that the alternate-week system be used—is not practicable, and will result in demoralization. The only answer to this is that three years of operation at Cincinnati, and shorter periods of operation elsewhere, have demonstrated that the criticism is untenable. Two alternating students work very well together and there is no confusion. Emphasis is laid upon this, because before the coöperative system was started this objection was the greatest obstacle in the way of its adoption. Men who were skeptical about this phase of the work have become enthusiastic over the smooth working of the system after a fair trial.

Training of Citizens Vital Part of any Worthy System

It is with hesitancy that a certain feature of industrial education is touched upon at this point, in view of the many propaganda that are being made in favor of it. There is a belief that there will be a tendency to swing too far in the "practical" direction, and that the impetus now being given to trade education may result in a too material training of the youth of the country, injuring to a certain extent that phase of education which should tend to the training of all civic units for civic service. In other words, the fact that every unit is a citizen of a republic, and that the republic depends for its stability upon the character of the mass, must not be overlooked. Fundamentally and primarily, as stated at the beginning of this article, the training of men to become citizens of a republic must be a vital part of any worthy system.

The object of all education is to make good citizens, and the first duty of a good citizen is to earn his own living. The second duty is to be a good citizen in the civic sense. All education, whether industrial or otherwise, should be directed toward these two very important phases of our national life. Here again is a very strong reason why the whole problem of industrial education should be solved in the public schools, where there will be the check of conservatism as to the character of the work, and where the whole solution will be under the direction of men who are servants of the public, and who naturally and by tradition look upon the problem with the widest and safest vision.

The writer has purposely omitted going into definite details, curricula, etc.; for instance, as to how a student should be instructed in arithmetic, algebra and chemistry. At the present these do not constitute the problem, and even if they did, enough work has been done in different kinds of schools to demonstrate clearly the character of instruction which ought to be given. The problem confronting us is the method of comprehensive action for the whole situation in the United States. We cannot adopt the German system, for the simple reason that the social stratification in Germany is horizontal, while in this country it is vertical. That is to say, the problem in this country is to find the highest elevation which any man's ability will permit him to reach, and to get him the elevation.



"I'll core it out and save money." 1. How the draftsman *looked at* it.

"I stop at the cored recess. My ticket don't pay me for counterboring." 2. How the machinist *saw* it.

"Damn! I'll have to chip it out." 3. How the erector *peeped at* it.

"Great Guns!" 4. How the owner *stared at* it.

The View Point

AMERICAN MACHINIST

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None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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A Vindication of the Independence of the Press

The result of a recent action at law against our associated paper *Power and the Engineer* is so well expressed in an editorial published in that paper that we reproduce it entire below. The result cannot fail to strengthen the hands of every editor who seeks to do his full duty by his readers. The editorial is as follows:

In the summer of 1907 one John E. Carroll, of Philadelphia, undertook the exploitation of an engine to run with carbonic-acid gas. There was no harm in this, for an engine will run with carbonic-acid gas as well as it will with air or steam—but no better. The half-page advertisements of the CO_2 Development Company, however, described the carbonic-acid gas which pours out of every chimney and arises from every fermenting tub as a vast "source of energy." So is water a source of energy, if it is elevated and free to fall. So is air a source of energy, if it is compressed and free to expand. But out of neither the water nor the air can more energy be got than has been expended in elevating or compressing it.

When, therefore, Mr. Carroll maintained that if he charged his engine with carbonic-acid gas under pressure it would continue to run forever if the gas did not leak out, and that under the ordinary condition of stuffing boxes it would continue to run and develop power in large and useful amounts for some 30 days, without any source of energy to draw upon, he stated what was opposed to all the known laws of physics and mechanics; something which, if true, would mean more to *Power* and all that it represents than the invention of the steam engine; something which was so thoroughly revolutionary that its possibility could be admitted only after a demonstration positive and satisfying enough to warrant upsetting the principle of the conservation of energy, and all the sciences which are founded thereupon. The demonstration which we attended signally failed to fulfill these conditions. It was a farce. The inventor talked the most arrant nonsense and refused to make the simplest tests to prove that his "demonstration" was honest. The conclusion that the CO_2 engine was a clumsy trick for obtaining money by false pretenses was inevitable, and we did not hesitate to say so. The whole affair was too ridiculous for serious treatment, and so in a two-page article in our issue of September, 1907, we laughed it off the stage.

In consequence of the publication of this article, F. R. Low, its author and the senior editor of *Power*, was arrested something over a year later, upon a charge of criminal libel made by Carroll, when Mr. Low was in Philadelphia testifying to what he had seen in behalf of officers and stockholders of the company who had been honestly deceived into lending their names and money to the enterprise and who were then suing the alleged inventor.

We waived examination and were in due course formally indicted by a Philadelphia grand jury. Right here we wish to extend our grateful acknowledgments and thanks to the many friends who have assisted and offered assistance in the matter, especially to Jay M. Whitham, M. E., and A. C. Wood, M. E., whose testimony that they had examined the device and advised clients against investing in it would have been particularly valuable had it been admitted. As it was, however, the judge, after having heard enough evidently to satisfy himself of the nature of the case, ruled out all of our expert testimony and instructed the jury to find for the defendant.

The outcome is a victory for technical journalism, and for the honest inventor and investor. Anything less than so prompt and complete an acquittal might have tended to make editors over-cautious and prevented the prompt and complete exposé of the various get-rich-quick schemes which it is the function of the technical press to investigate and inform its readers about. One can well accept some indignities, and be put to some trouble and expense, for the reassertion of the right of the editor to expose in the broadest and most positive terms what he concludes, after careful investigation, to be a fraud.

The Lubrication of Machine Tools

We do not as a rule think very much about the lubrication of machine tools because in most cases the designer has provided ample opportunity in the way of oil holes and tubes. But the proper attention to these is another matter and we have it on the authority of a very observant shop owner, that over 90 per cent. of the repairs that are made on their machine tools comes, primarily, from lack of proper lubrication while in use.

He does not blame the designer nor the builder but rather the lack of instruction as to the proper oiling of the machine, to the man or boy who is running it. The damage comes more often from the boy who is left to his own devices, owing to the foreman being busy with other duties, and we all know the damage that can be done by allowing a few bearings to run dry.

He advocates that special attention be paid to instructing boys how to take care of machine tools, and that no boy should be put on a machine until he has been thoroughly instructed as to how to take care of as well as operate it. A pair of gears thrown in at the wrong time may put a thousand-dollar machine out of commission for a week, and would pay for

the necessary instruction many times over. The same is true about lubrication, and as the cost of accidents and wear due to this cause is so much greater than all the rest, it will certainly pay to devote all the time necessary to giving thorough instruction in regard to it.

It is an old saying, and a very true one, that you cannot *use* too much oil on any machine. But in the endeavor to put on only enough to prevent damage, some, particularly in railroad work, have economized to such an extent that every dollar saved cost anywhere from two to ten dollars in repair bills. While this is more true of the locomotives than of the tools in the shop it makes a good example of a false economy that should be avoided by all who may be tempted to save a little on the oil bills. There is no question as to some oil being wasted in almost any place where it is used but it is one of those places where it is better to waste a little than run the risk of a greater expense by attempting to save it. There is no question that less oil could be used but the repair bills should be watched carefully before a final balance is struck.

The cost of lubrication is such a small item as compared with other expenses of a shop that it may almost be neglected, but we should turn our attention to the proper education of apprentices, and workmen too in the case of a new tool coming into the shop, as to how it should be lubricated to avoid all chances of disaster.

Methods of Paying Men

One of the features of shop management which has undergone little change in many shops is that of paying off the men, the old method of standing in line and passing in front of an enlarged knot hole being still in vogue in too many cases.

The old time keeper has given way to the time clock and other more or less complicated methods by which the men now register their own arrival and departure, but there is still the same old scramble after the pay envelop in shops that are otherwise modern.

A flagrant example of this was noted recently when the pay car of a well known railroad reached a small town where perhaps fifty men were waiting for their ever necessary pay. They lined up on both sides of the track, made a flying grab for the handles and jam at the car door in a way that would have done credit to a college rush. The car and train must not be delayed and the scramble was almost a necessity. But whether it was or not, the method should be so changed as to make it out of the question. A safeguard should be thrown around the men who ignorantly or otherwise, risk life or limb to save a moment's time. In this case the station agent could act as paymaster without difficulty.

In some shops the pay line extends around the block and the men lose from five to thirty minutes each, an aggregate of two hundred and fifty hours at an average of fifteen minutes each, where a thousand men are employed.

Owing to a habit of looking at the payment of money as a special favor, instead of as a simple acknowledgment of value received, we have grown to look at this as being perfectly natural and right, when in reality it is not. After a man has earned his money he is entitled to it without spending more time in its collection or demeaning himself in any way to obtain it.

When a piece of work is finished and delivered, we expect a check on the day agreed upon by custom or otherwise, without spending time and money to collect it and though it is often necessary to do both, we do not form a higher opinion of the debtor on that account.

In paying our bills for materials we spend money to mail or send the amount due and yet we too often adopt the opposite plan in paying for labor.

It is purely a matter of habit and custom but one that is not to be commended in most cases. It costs very little to deliver the money to the men while at work, at any time that is deemed best in any particular shop, and the effect on the men will in most cases at least, be ample return for the time and trouble it may take.

New Publications

MECHANICAL DRAWING AND ELEMENTARY MACHINE DESIGN. By John S. Reid and David Reid. Second edition; 439 6x9-inch pages; 317 illustrations; indexed. John Wiley & Sons, New York City. Price, $3.

This edition is enlarged over its predecessor by the addition of a course in machine drawing and elementary machine design, known as Course II, for students who have completed a full course in mechanical drawing; a course in lettering for students who have not had its equivalent in preparatory work, and a course (Course III) intended to supplement Course II, consisting of machine sketching, making working drawings from sketches, isothermal drawing of piping layouts and machine design. Another addition, and, by the way, the best part of the book, is a chapter on drawing-room conventions prepared from answers received from many drafting rooms to a series of categorical questions sent out by one of the authors. In general the work has not improved in this second edition. Many crudities exist, statements are found that do not agree with the best of drafting-room practice; see page 18, where the use of blueprints is decried in favor of "working drawings . . . . on cards." As an example of loose definition we quote, "A screw is a helical projection or thread formed upon a cylinder. . . . ."

LAW AND BUSINESS OF ENGINEERING AND CONTRACTING. By Charles Evan Fowler. 162 6x9-inch pages; numerous forms; indexed. McGraw Publishing Company, New York City. Price, $2.50.

This book is the outgrowth of a series of lectures delivered to engineering students of the University of Washington. The first chapter, Relation between the Engineer and Contractor, is written from the text, "Do unto others as you would have others do unto you." It makes an earnest plea for a better understanding and more harmonious action between the contractor and the engineer-in-charge. Their common meeting ground should be on the broad plane of professional intelligence and good common sense. The second and third chapters treat of Ordinary Forms of Contracts, and Ordinary Specifications. Numerous typical forms for contracts and specifications are given, and the vital points are indicated and explained. The next two chapters deal with Special Forms of Specifications, and Special Forms of Contracts. Then follows a chapter on Inspection of Engineering Work. Much good advice is given to the young engineer inspector; he is warned not to "strain at a gnat and swallow a camel." The remaining chapters deal with Estimating Materials and the Cost of Engineering Structures; Bidding on Engineering Work; Organization of Contract Work; Essentials of Contract Law. Much practical advice, seasoned by experience, is contained in these chapters; advice that cannot fail to be of value to the young engineer if he will but heed it. The value of a business training is wisely emphasized. The work is of real value and we take pleasure in commending it.

Personals

H. W. Canning, formerly representing the Murphy Iron Works in Birmingham, Ala., has been put in charge of his company's New York City office.

Arthur Williams, general inspector of the New York Edison Company has been elected member of the Board of Trustees of the Museum of Safety and Sanitation.

John L. Bacon, formerly connected with the Lewis Institute and the Miehle Printing Press Company, is now engineer and superintendent of construction with N. P. Shields & Co., San Diego, Cal.

Hans Schulze, machine-tool importer, Bruenn, Vienna, Austria, is in this country for a few days making agency connections for lines he does not now represent. Mr. Schulze can be addressed in our care.

E. R. Douglas, who has been for the last three years superintendent for Adriance, Platt & Company, Poughkeepsie, N. Y., has left them to accept the position of works manager for the Hero Fruit Jar Company, Philadelphia, Penn.

*Items for this column are solicited.

New Tools and Machine Shop Appliances

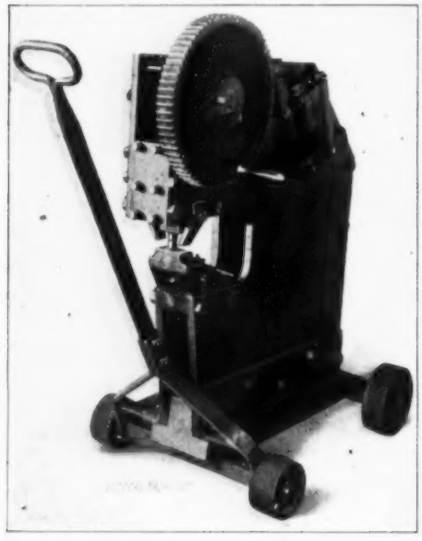
Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A High Power I-beam and Channel Hand Punch

While the trend of modern demands is shifting to motor- and power-driven machines, yet the advantages, capacity, ease of operation and durability of the hand-power punch illustrated herewith makes it adaptable to all kinds of punching on I-beams from 5 inches up to 12 inches. It is built of light weight armor plate, is strong and rigid, and will easily and quickly punch a medium sized hole in plates up to ½ inch thick.

The maximum capacity of this punch is 1-inch holes in ½-inch plate, which would take a dead weight of over 47 tons upon the plunger, based upon a shearing strength, of the material being punched,



HIGH-POWER CHANNEL AND I-BEAM HAND PUNCH

of 50,000 pounds to the square inch; which is equivalent to the ordinary steel used in bridges and structural steel work of all kinds. This power is made possible by a combined 3-stage lever motion, which has a leverage of 1 to 2200 from the end of a 6-foot lever to the shearing edge of the punch. This is equivalent to 2200 pounds pressure at the punch with 1 pound pull on the lever. The ratchet wheel is cut and hardened steel upon which works the pawl and lever motion, and there are three pins in the lever handle over which the first link is placed to secure a one-, two- or three-tooth movement of the ratchet wheel. The ratchet wheel can be turned by a convenient handle to quickly adjust the punch to the work, as well as to run the punch up after completing an operation.

The throw of the crank shaft is ¾ inch, and the motion is transferred to the plunger head by means of a heavy steel one-piece connecting rod, which is bronze bushed.

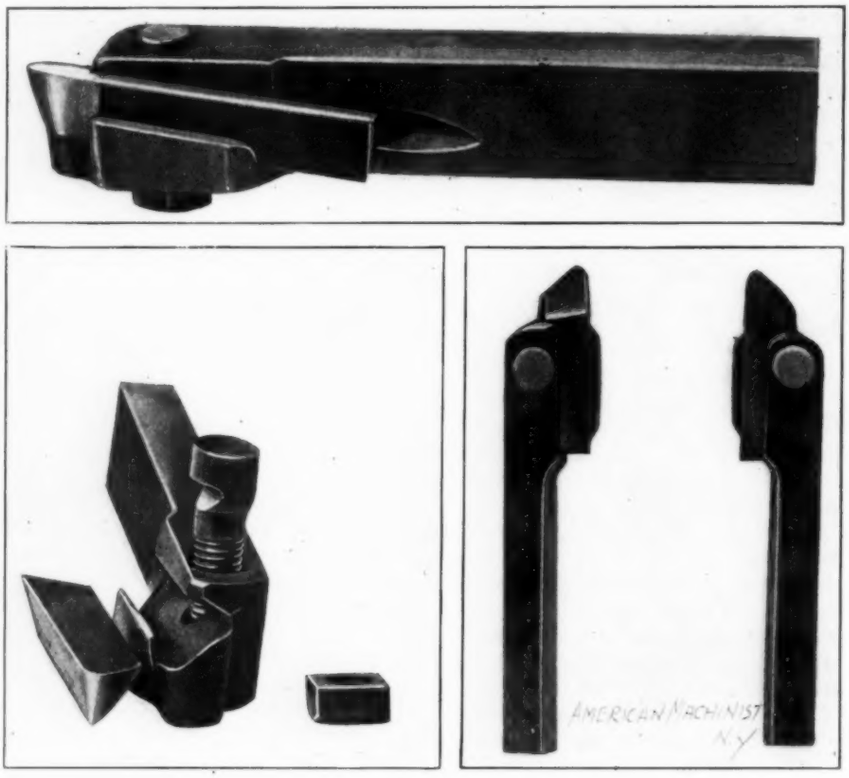
The planed sides of the frame form guiding surfaces on two sides of the plunger while the main guides are bolted between the frame and have adjustable gibs which assure the permanent alinement of the punch and die. The die holder is a steel casting of improved shape and design adaptable to working on webs of channels, I-beam, etc. Its weight is 1000 pounds, and it can be mounted on a truck for portable use. The machine is made by the Buffalo Forge Company, Buffalo, N. Y., and has been styled their No. 30 punch.

A New Iron Filler Cement

The S. Obermayer Company, of Cincinnati, has developed a new compound called the National iron filler cement for filling cracks and holes in defective castings. The cement is supplied in the form of a powder which is mixed with water to the consistency of a stiff putty. After filling the holes it hardens and accomplishes the desired purpose.

A Tool Holder

The halftone shows a new tool holder which has recently been brought out by the G. R. Lang Company, Meadville, Penn.



A TOOL HOLDER

The cutter is triangular in section and this shape together with location of the angles of V-shaped seat in which it rests preclude the necessity of grinding clearances on the top and side, and it is only necessary to grind the end of the tool when it becomes dull. The depth of the cutter under the point is the whole face of one side making it very stiff. This method of holding the cutter permits the tool to be fed right up to a shoulder and

it is not necessary to have an offset holder.

The stock for the cutters can be obtained in the open market either in carbon or high-speed steel.

An All-steel Tool Rack

The accompanying illustration shows an all-steel tool rack made by the Davis Manufacturing Company, Milwaukee, Wis. It consists of a back and sides of sheet steel supporting two shelves and a drawer,

AN ALL-STEEL TOOL RACK

with a bottom and partial front that form a bin; a convenient place for waste. The dimensions are 18 inches square and 36 inches high. Both shelves are surrounded on three sides so that tools cannot roll off.

A Hole-centering and Laying-out Tool

A convenient small tool for centering holes and laying out work therefrom is the development of Max Jaeger, of 109 North Terrace avenue, Mt. Vernon, N. Y. It is illustrated by the halftones, Figs. 1 and 2, and its use is shown by Fig. 3.

It consists of a graduated dial or plate having on its upper surface a ratchet *1* with a spring-controlled pawl *2* and a center hole *7*. Beneath are three latches *3* and a cam plate that controls their movement. To center the device in a hole the latches are extended until the shoulders near their ends engage the edge of the hole as shown in the small detail in the upper right-hand corner of Fig. *2*; there *3* indicates a latch and *5* and *4* the surfaces of the shoulder engaging the edge of the hole. This is brought about by turning the ratchet *1* in the direction of the arrow, which, in turn, rotates the cam plate in contact with the latches. The spring *6* acting on the pawl *2* keeps the latches against the work through the intermediary of the ratchet and cam plate.

When the tool is thus set in a hole the center of the hole is available for purposes of laying out by the hole *7* of Fig. 1. The bottom of this hole is on a level with the horizontal face of the shoulders of the latches.

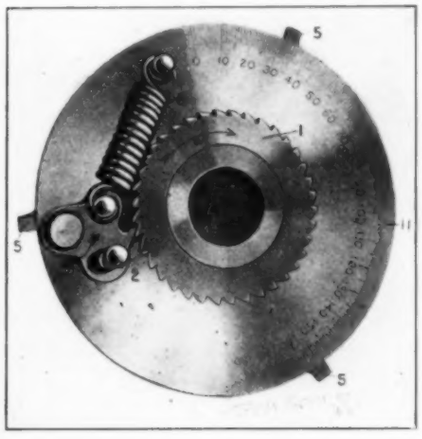


FIG. 1. TOP VIEW OF HOLE-CENTERING AND LAYING-OUT TOOL

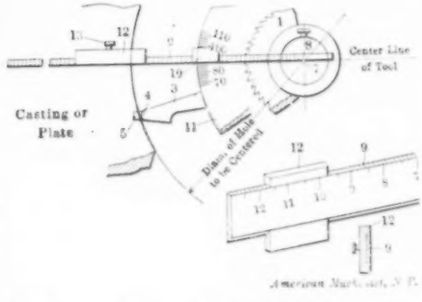


FIG. 3. METHOD OF USING HOLE-CENTERING AND LAYING-OUT TOOL

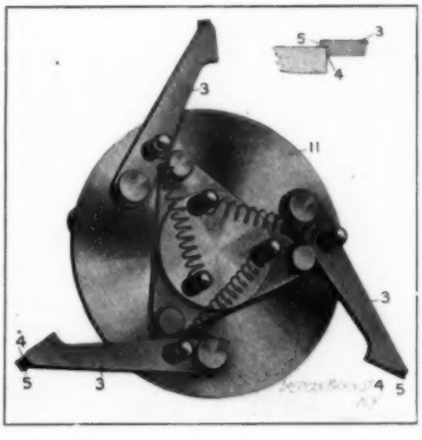


FIG. 2. BOTTOM VIEW OF HOLE-CENTERING AND LAYING-OUT TOOL

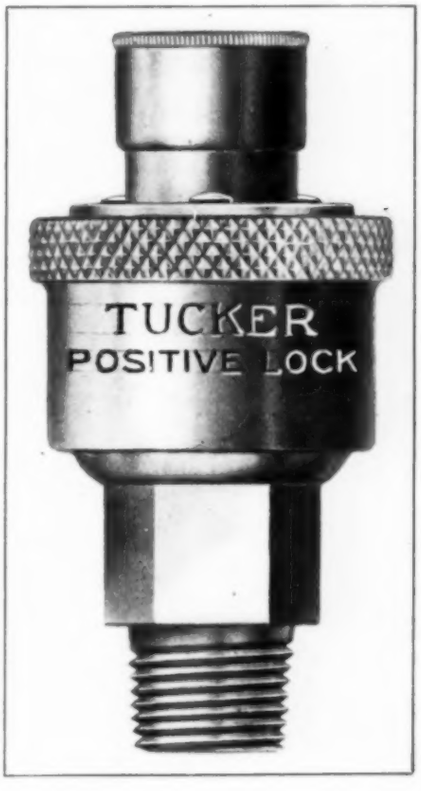
Compare the operation of centering with this tool, and the familiar machine-shop method of driving a block of wood into a hole, chalking it, and trying for the center with dividers.

The second use of the tool is in laying out holes on surfaces from a hole already centered, see Fig. 3. Into the socket in the ratchet is fitted a scale *9* carrying a rider *12*. This rider can be clamped in any desired position by the screw *13*. Thus a radius can be laid off and scribed by setting the rider *12* to the proper graduation and scribing therefrom. By means of the graduations on the disk holes can be laid out at given angles from each other and with proper relation to the center hole.

The tool is in several sizes, thus adapted for various sizes of work.

A Positive Lock Compression Grease Cup

The illustration shows a new addition to the list of lubricators made by W. A. & C. F. Tucker, of Hartford, Conn. The locking feature, of which the mechanism is covered from exposure to dirt, makes it suitable for machinery which is subject to vibration, including automobiles. Detailed description is unnecessary further than to say the lock is conveniently located on the top of the cup and that the entire cup is very compact.



A POSITIVE LOCK COMPRESSION GREASE CUP

A Shaper with a New Down Feed Attachment

The Queen City Machine Tool Company, Cincinnati, Ohio, has brought out a new attachment for giving a vertical power feed which is very compact and entirely out of the way. In Figs. 2, 3 and 4 can be seen the plunger *A* projecting from the side of the ram and held out by the spring at the other end and inside the ram. On this plunger is a rack engaging the pinion *B*, which is on a sleeve and turns the shaft *C* through the clutch at the back end, and from this through the medium of the small bevel pinion, turns the nut *D* around the screw. This feeds the head down without turning the screw. Motion is imparted to the plunger by the dog or stop *E*, which can be located in the slot shown to accommodate the positioning of the ram. This and the plunger are shown in Fig. 1. In addition to this there is an automatic stop, which can be set to throw out the feed at any particular place. The clutch at the back end of the shaft can be thrown out of operation by a stop pin controlled by the graduated dial, shown in Fig. 4. This dial is visible on the side of the ram, so that it can be set to the desired point without loss of time. The rotation of this stop is secured by the worm and worm wheel. The stop controlling the clutch shifts it so that when the desired position is reached the clutch is disengaged. The setting of the stop is easily controlled and all the mechanism is out of the way inside the ram. Fig. 1 shows a new universal table on the shaper and a very substantial form of vise. The table swivels on the saddle, has a tilting top and a vise with a swiveling base, so that the work can be held in about any position that may be desired.

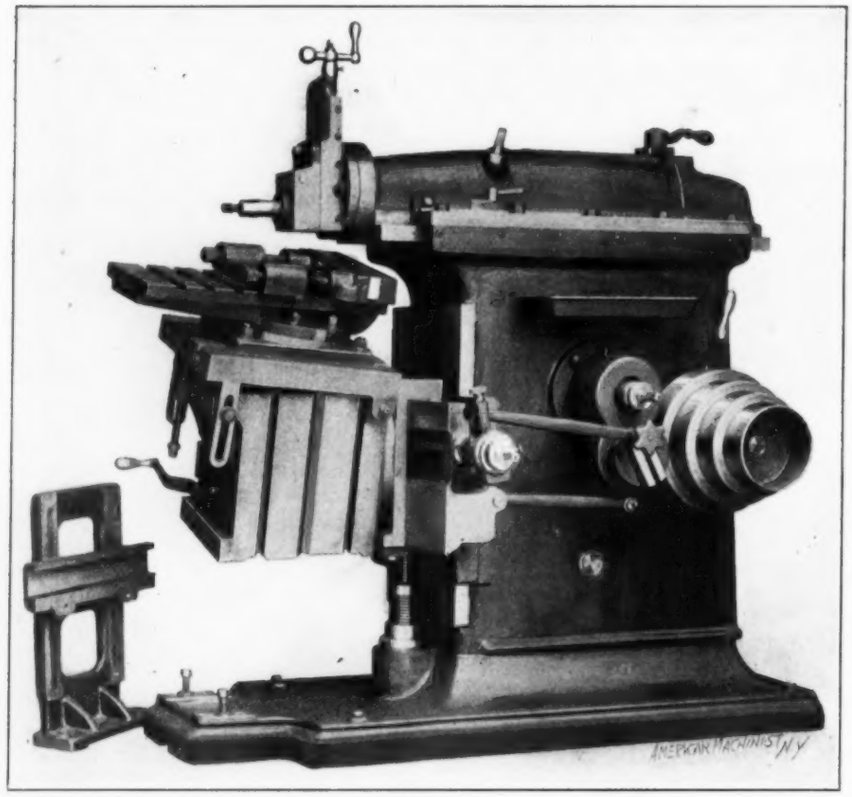
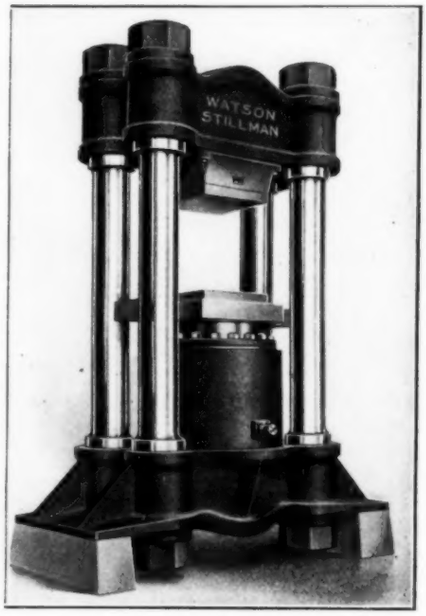


FIG. 1. QUEEN CITY SHAPER WITH DOWN FEED ATTACHMENT

A Hydraulic Press

The illustration shows a 2000-ton hydraulic press which was recently built by the Watson-Stillman Company, New York. The ram is 30 inches diameter by 12 inches stroke, and works under a pressure of 5700 pounds per square inch.

The anvil is 24 inches square. The distance between rods is 3 feet 9 inches. Hight of machine over all is 12 feet 5½ inches, and from foundation 11 feet 6¼ inches. The head, base and cylinder are steel castings.



A HYDRAULIC PRESS

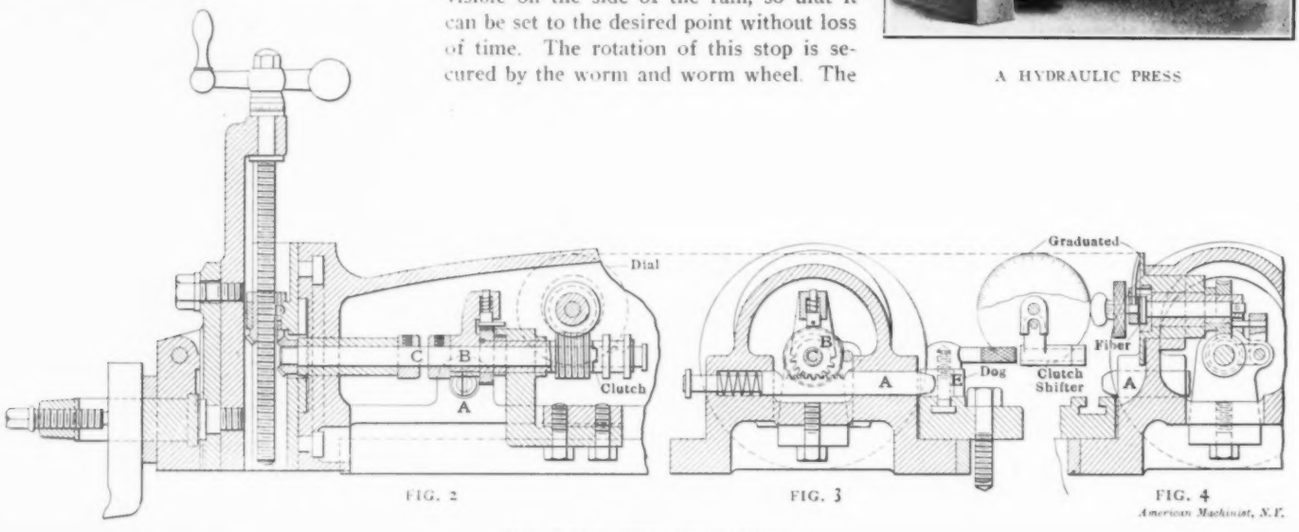


FIG. 2 FIG. 3 FIG. 4
American Machinist, N.Y.

THE DOWN FEED MECHANISM

Some New Interesting Drilling Features

The new feature of the 20-inch drill, shown in Fig. 1, is the positive feed arrangement which is contained in the feed box just behind the hand lever. The feed consists of a double cone of four gears each with a sliding key controlled by the handle in the spiral slot of the sleeve above the feed box. This drill also allows both the feed worm and the driving bevel gear to be thrown out, the former by a trip and the latter by hand.

In Fig. 2 is shown a new tapping attachment having a double bevel pinion for obtaining the forward and reverse movements. The first pinion drives the lower bevel gear while the second drives the upper and smaller gear, giving a faster reverse. The clutch sleeve extends up inside the upper gear hub and gives a long key in the spindle so that the trouble sometimes arising from this cause has been eliminated. The clutch is controlled by the lever in front and either the slow forward or fast reverse motion is obtained at will.

The feed box is a little different on this machine and consists of double cones of three gears, controlled by one of the handles below instead of above as in the other case, while the other throws a back gear in or out, giving six changes of feed instead of four as in the other machine.

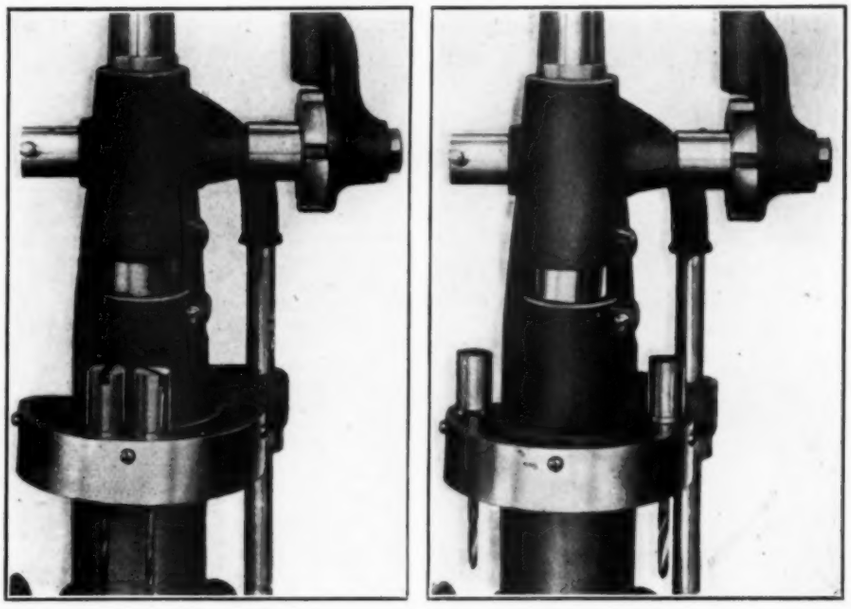


FIG. 3. DOUBLE SPINDLE ATTACHMENT

Fig. 3 shows a very neat little double spindle attachment which goes right on the end of the main spindle sleeve. A gear fitted with a taper shank goes into the drill spindle and meshes into a small gear on each of the auxiliary drill spindles. These can be adjusted in any position in the slot around the main driving gear and set at the desired point by simply tightening the slotted nuts shown. These auxiliary spindles have taper sockets for driving the drills used. These are all recent productions of the Mechanics' Machine Company, Rockford, Ill.

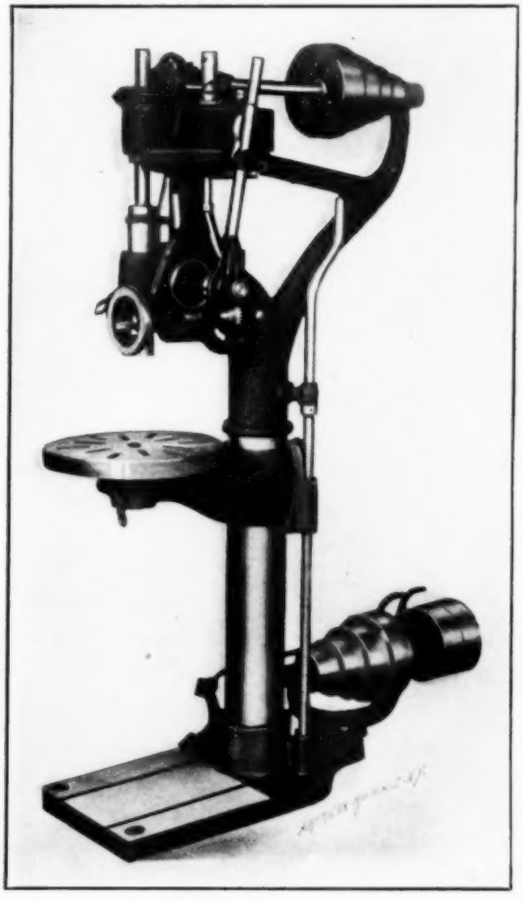


FIG. 1. TWENTY-INCH DRILL WITH POSITIVE FEED

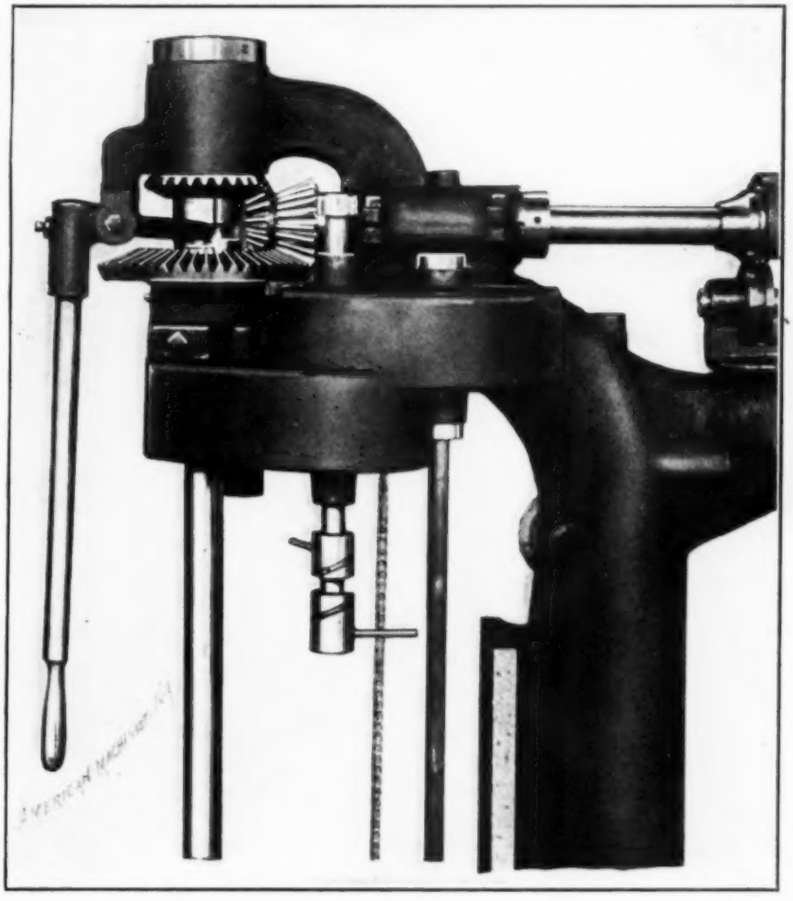
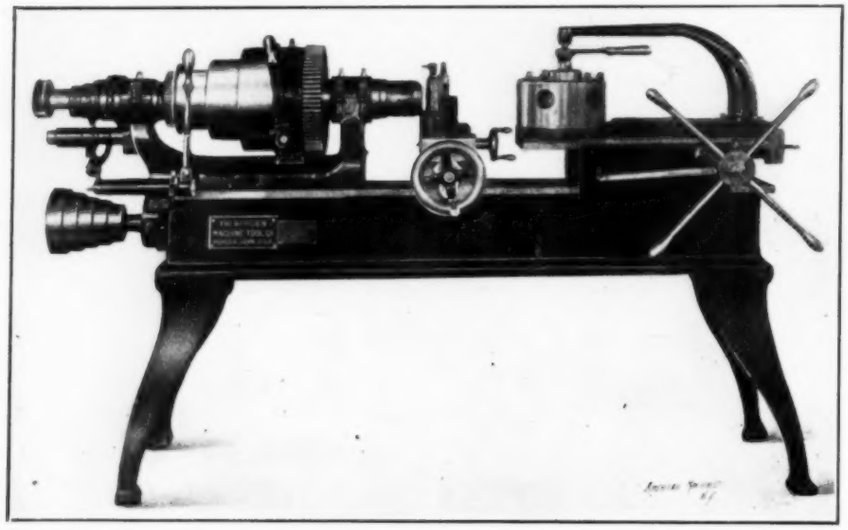


FIG. 2. TAPPING ATTACHMENT

New Turret and Forming Lathe

The illustration shows a new 20-inch friction-head back-geared turret and



A NEW TURRET LATHE

forming lathe built by the Meriden Machine Tool Company, Meriden, Conn. This machine has a number of interesting features. In the turret base there are two taper shoes which rest upon the top of the lathe bed. These are for the vertical adjustment of the turret, and on each side of the turret slide are taper gibs by which the turret has a lateral adjustment. Thus the turret can always be kept in alinement.

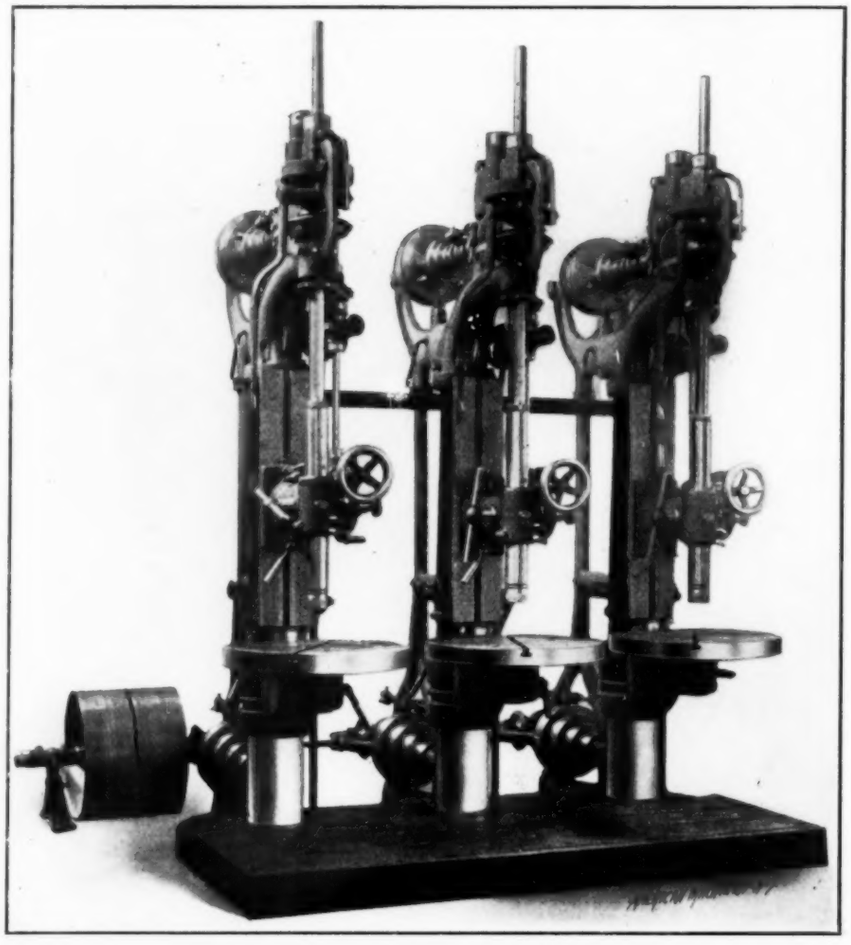
Another convenient feature of this turret lathe is that the lever which operates the automatic chuck by means of a cam, is at the side of the machine in a convenient position for the operator. The operator can, in fact, reach and handle all working levers without walking from one end of the machine to the other. The turret lathe has independent tool stops and power feed for the turret with five rates of feed. The turret feed can be thrown in or out at any point of the cut by a lever upon the front of the turret base and the feed is thrown out automatically at the end of the cut by the independent tool stops. The distance from the top of the turret slide to the center of the holes in the turret is made either 3¼ or 4 inches as desired to facilitate the use of self-opening dies and large box tools, and to maintain rigidity a fork brace is placed from the back end of the turret slide to the top of the turret stud. The illustration shows the machine equipped with a cut-off slide, but it can be equipped with a forming slide instead if required. This turret lathe has a 6-foot bed. The largest diameter of cone is 12 inches, the width of belt 3½ inches. The hole through the spindle is 2 inches diameter. The machine weighs 2240 pounds.

Gang Drill with Tapping Heads

The illustration shows the first machine of this type built by the Rockford Drilling Machine Company, Rockford, Ill., which is a 3-spindle drill of 31-inch capacity having an extra long spindle travel of 25 inches.

The three frames are tied together with a heavy brace and all three spindles are equipped with their regular tapping attachment.

The machine has a single belt drive and in addition to the regular belt feed for drilling, there is a special fast feed for reaming. This is positive, being driven by the chain from the sprocket below the crown gear. The standard features of the machine have been illustrated in a previous issue.



GANG DRILL WITH THREE TAPPING HEADS

Experience with the electric furnace in foreign countries has shown that it will purify the metal to a larger extent than the gas furnace or the bessemer converter, and advanced practice proposes to use it as an adjunct to the ordinary processes of steel manufacture for the purpose of reducing the amount of phosphorus and sulphur and to deoxidize the bath. After a careful investigation by its metallurgists, the United States Steel Corporation has decided to try a 15-ton Heroult electric furnace at the South Chicago works. Three-phase alternating current will be used and it is proposed to use the product for high-grade steel rails. The capacity of one furnace is sufficient for the production of 500 tons of steel in 24 hours. The experiment is expected to be made at the South Chicago works this summer.

Forthcoming Meetings

American Hardware Manufacturers Association, joint convention with Northern Hardware Jobbers Association, Pittsburg, Penn., June 9-11, headquarters, Hotel Schenley. F. D. Mitchell, secretary, 309 Broadway, New York City.

Engineers Society of Pennsylvania, first annual convention, Harrisburg, Penn., June 9-10-11, headquarters, Capitol building; E. R. Dasher, secretary.

Railway Master Mechanics Association, annual convention, June 16-18, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

Master Car Builders Association, annual convention, June 21-23, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

National Gas and Gasolene Engine Trades Association, meeting, June 22, 23, 24, South Bend, Ind., headquarters, Oliver hotel. Albert Steltwatter, Cincinnati, Ohio.

Society for the Promotion of Engineering Education, seventh annual convention, June 24-25-26, Columbia University, New York, and Pratt Institute, Brooklyn, N. Y. Arthur L. Williston, secretary, Pratt Institute, Brooklyn, N. Y.

The Society of Naval Architects and Marine Engineers, summer convention, June 24-26, Detroit, Mich., headquarters, Hotel Pontchartrain. W. J. Baxter, secretary, 29 West Thirty-ninth street, New York City.

American Society of Testing Materials, annual meeting, June 29, Atlantic City, N. J., Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Penn.

Business Items

The New York office of the Norton Company, Worcester, Mass., has been moved to 50 Church street (Hudson Terminal building).

D. G. Clark has been admitted into partnership in the firm of E. S. Jackman & Co., Chicago, agents for the Firth-Sterling Steel Company.

The Carpenter Steel Company, Reading, Penn., has opened a branch office and warehouse at 189 Allyn street, Hartford, Conn., where it will carry a full stock of tool steels. George C. Cairnes is manager.

Hugo Bilgram, Philadelphia, has disposed of his machine business to the Bilgram Machine Works. The officers of the new corporation are Hugo Bilgram, president; Max Uhlmann, vice-president; J. Rollin Parker, secretary; Bertha Bilgram, treasurer.

The Stoever Foundry and Manufacturing Company, Myerstown, Penn., with sales office at 140 Cedar street, New York, reports the sale of twelve of their No. 12 type "H" pipe-threading and cuttingoff machines, motor-driven, capacity, 4 to 12 inches, to Spang-Chalfant & Co., Pittsburg, Penn., for equipment of its new mill. The Stoever Foundry and Manufacturing Company advises that it is running full at its factory and has very few, if any machines, on stock.

The Macbeth Iron Company, of Cleveland, Ohio, engineers, founders and machinists, builders of blowing engines, etc., and the Bruce-Meriam-Abbott Company, also of Cleveland, builders of gas engines, were consolidated on June 1, the name of the new company being the Bruce-Macbeth Engine Company. It is the intention of the new company to concentrate the two present plants in the former plant of the Macbeth Iron Company, on Center street, N. W., Cleveland. Alterations to the present buildings will be made and several new buildings will be erected to accommodate the enlarged business. The officers of the company are as follows: President, W. C. Bruce; vice-president, C. W. Kelly; secretary and treasurer, C. J. Snow; manager, C. E. Curtiss.

Business Opportunities

The Waukesha (Wis.) Motor Company will erect a new plant.

C. H. Perry, Miami, Fla., will erect an automobile repair shop.

A four-story addition will be built to the Laurens (S. C.) cotton mill.

The Munroe (Wis.) Light and Fuel Company is building a new gas plant.

The Landis Tool Company, Waynesboro, Penn., will erect a new machine shop.

The Decatur (Ind.) Furnace Company will build an addition to its molding room.

The Giel Boat and Engine Company, Ludington, Mich., is putting up a new factory.

Kahlert & Holman, New Orleans, La., will establish an iron foundry in Quanah, Texas.

The P. A. Geier Company, Cleveland, Ohio, will increase the capacity of its machine shop.

The Universal Machine Screw Company, Hartford, Conn., has bought a site for a new plant.

The Otis-Fensom Elevator Company, Hamilton, Ont., is building an addition to its plant.

The Beebe Syndicate, Syracuse, N. Y., has awarded contract for the erection of new repair shops.

Murray M. Stewart, of Savannah, Ga., is interested in a plan to build a cotton mill at Vidolia, Ga.

The White & Bagley Company, Worcester, Mass., manufacturing lubricants, is to erect a new plant.

Morris & Co., of Chicago, Ill., will establish a packing plant at Oklahoma City, to cost over $2,000,000.

The Hollingsworth & Whitney Paper Company, Madison, Me., will erect a new paper mill and pulp mill.

The roundhouse of the Santa Fe road, at Canadian, Texas, was destroyed by fire. It will be rebuilt at once.

The Kankakee (Ill.) Electric Light and Power Company has had plans prepared for a new electric-power plant.

G. V. Van Platten, of Boyne City, Mich., will erect a sawmill at Florence, Wis. May also erect chemical plant.

The American Spring and Mattress Company, Cedar Rapids, Iowa, is having plans prepared for a new plant.

The locomotive shops of the Erie railroad, at Hornell, N. Y., are to be enlarged; 300 more men will be employed.

The Frank Mossberg Company, Attleboro, Mass., manufacturing wrenches, special tools, etc., will erect a new plant.

The Zimmerman Steel Company, Lone Tree, Iowa, will spend $15,000 in improvements to its foundry and steel plant.

The Leader Foundry and Machine Company, Quincy, Ill., is erecting a new plant for making general foundry castings.

The Buckeye Steel Castings Company, Columbus, Ohio, is to erect two additions to its plant to cost about $300,000.

The Vetter Manufacturing Company, Stevens Point, Wis., making sash, doors and blinds, is building a new plant.

The Canton (Ohio) Drop Forging and Manufacturing Company is planning to erect an addition to its machine shop.

The Hays Manufacturing Company, Erie, Penn., brass workers and finishers, are building an addition to its machine shop.

The main building of the Carlisle (Penn.) Frog and Switch Works, was destroyed by fire, causing a loss of over $150,000.

The japanning department of the John Radel Leather Company, Newark, N. J., was destroyed by fire. Loss, about $10,000.

The Frost Wire Fence Company, Hamilton, Ont., will, in the future, draw its own wire and is erecting a plant for this purpose.

The Sterling Wheelbarrow Company, Milwaukee, Wis., has bought a site in West Allis, where a new and larger plant will be erected.

The Syracuse (N. Y.) Motor Car Company is having a new garage erected to be equipped with modern machinery for automobile repairs.

The Martin Dyeing and Finishing Company, Bridgeton, N. J., will build an addition to its factory and also enlarge the power plant.

O. C. Little, of the Onward Manufacturing Company, Menasha, Wis., is buying machinery for a glass factory to be erected shortly.

The Hardware Supply Company, Grand Rapids, Mich., manufacture furniture hardware, etc., will erect a plant at Hamilton, Ontario.

The Dominion Iron and Steel Company, Sydney, N. S., will erect extensive additions to its plant, on which about $5,000,000 will be spent.

The Stanley G. I. Electric Manufacturing Company, Pittsfield, Mass., is having plans prepared for addition to its foundry to cost $100,000.

The plant of the Lake Washington Mill Company and the Lake Washington Turning and Scroll Works, Seattle, Wash., were destroyed by fire.

The Nuss Plating Company, Harrisburg, Penn., will build a new plant. The company manufactures band instruments and does all kinds of plating.

The Atlas Car and Manufacturing Company, Cleveland, O., will buy some more new tools, including radial drills, lathes, double-end axle lathes, planer, etc.

The Washington Iron Works, Seattle, Wash., is erecting a new boiler shop, which is to be equipped with shearing, punching and riveting machinery, etc.

The R. L. Morgan Company, Worcester, Mass., a new company with $300,000 capital, has leased a plant and will engage in the manufacture of motor trucks.

The Columbus (Ga.) Manufacturing Company will build an addition to its cotton mill, which will double its capacity. It is said about $500,000 will be expended.

The O. J. Beaudette Body Company, Pontiac, Mich., is erecting a three-story addition to be devoted to the manufacture of aluminum bodies for automobiles.

It is said the Yazoo & Mississippi Valley railroad will build a roundhouse and repair shop at Clarksdale, Miss. W. S. King, Memphis, Tenn., general superintendent.

It is reported that the Charlotte Harbor and Northern railway is having plans prepared by E. C. Bagwell, superintendent, Hull, Florida, for machine shops at Arcadia, Fla.

The Monitor Drill Company is to make extensions to its plant at St. Louis Park, a suburb of Minneapolis, Minn., which will include an addition to the foundry and a new power house.

The American Die and Tool Company, Reading, Penn., which recently purchased a lot of machinery, is still in the market for several milling machines, lathes and tooth-chamfering machine.

The Hayward Wagon Company, Baldwinsville, N. Y., will move to Newark, N. J., where a new plant will be erected. This will include a machine shop, carpentry shop and assembling room.

The Nickerson-McFarlane Machinery Company, Tacoma, Wash., is erecting a new machine shop. The company will need a 10-ton crane, shaft lathe, lathe, bolt-threading machine, power hammer, boring mill.

The Walworth & Neville Manufacturing Company, Pinebur, Miss., will rebuild its plant recently burned; will replace machine shop, blacksmith shop, boiler shop and electric-light plant. The company manufactures cross arms, pins, etc.

New Incorporations

B. A. Kelley & Co., Belfast, Me., has incorporated to manufacture edged tools. Capital, $10,000. Elmer I. Rankin, president.

The Southington Manufacturing Company, Southington, Con., has been organized to manufacture automobile kits and to finish automobile forgings.

R. L. Morgan Company, Worcester, Mass., incorporated to manufacture automobiles. Capital, $300,000. Incorporators, R. L. Morgan, H. E. Whitcomb.

The Smith Foundry Company, Lexington, Ohio, has been incorporated with $10,000 capital. Incorporators, A. F. Smith, H. H. Smith, Thomas Cureton, etc.

The Marathon Motor Car Company, Cincinnati, Ohio, has been incorporated with John Rahn, Jr., of the Rahn-Carpenter Company, as second vice-president.

The Lincoln Engineering Company, Portland, Me., has been incorporated to manufacture electrical and other machinery. Capital, $10,000. L. V. Walker, president.

Union Typewriter Company, Ilion, N. Y., has been incorporated. Capital, $20,000,000. Incorporators, J. W. Earle, G. K. Gilluly, New York, C. B. Hobbs, Great River, L. I.

The Reynolds-Mason Iron Company, Paterson, N. J., has incorporated as machinists, etc. Capital, $100,000. Incorporators, J. G. Reynolds, W. H. Mason, W. R. Huson.

The Bucksport Launch and Engine Works, Bucksport, Me., has been incorporated. Capital, $20,000. Walter R. Soper, president. Will manufacture engines, boats, automobiles.

National Manufacturing and Lock Company, Chicago, Ill., has been incorporated to manufacture hardware. Capital, $100,000. Incorporators, E. W. Potter, R. Goepfert, F. J. Wegg.

The Latham-Leethern Company, Chicago, Ill., has been incorporated to manufacture mechanical apparatus. Capital, $100,000. Incorporators, C. Martin, T. A. Sheehan, H. M. Byall.

Automatic Flareback Prevention Company, Camden, N. J., has been incorporated to manufacture ordnance, etc. Capital, $100,000. Incorporators, K. V. Myles, V. A. Murray, A. Martin.

The Muskingum & Morgan Railway, Light and Power Company, Zanesville, Ohio, has been incorporated by Andrew W. McDowell, R. C. Burton, W. H. Pierpont, etc. Capital, $10,000.

Mutual Automobile Association, New York, has been incorporated to manufacture automobiles, motor vehicles, etc. Capital, $50,000. Incorporators, F. Haasters, G. L. Clarke, O. B. Bachmann.

International Illuminating Company, Newark, N. J., has been incorporated. Capital, $2,000,000. Incorporators, R. M. Smith, G. Oestreicher, R. W. Cobb. Will manufacture gas fixtures.

Sprague Manufacturing Company, Boston, Mass., has been incorporated to manufacture machinery of all kinds. Capital, $50,000. Incorporators, C. E. Bixby, Waltham; H. M. Sprague, Boston.

Auto-Appliance Manufacturing Company, New York, has been incorporated to manufacture shock absorbers for motor cars. Capital, $25,000. Incorporators, W. J. Singer, J. W. Lowell, J. L. Douglass.

The Kathodion Castings Works, Kingston, N. Y., has been incorporated. Capital, $150,000. Incorporators, J. H. Dawe, G. C. Genet, L. F. Genet, New York. Will manufacture metals, metal goods, etc.

National Woodenware and Supply Company, Chicago, Ill., incorporated to manufacture woodenware and stock for same. Capital, $100,000. Incorporators, J. S. Pooley, C. G. Wyman, A. Schuetz, L. C. Ehle.

Kraub Manufacturing Company, Chicago, Ill., has been incorporated to manufacture punches, shears and special machinery. Capital, $100,000. Incorporators, R. Kraub, B. A. Kraub, G. Berry, T. H. Wunderlich.

The J. Alexander Manufacturing Company, New York, has been incorporated to manufacture electric fixtures and apparatus. Capital, $30,000. Incorporators, J. Alexander, A. S. Alexander, I. H. Alexander, C. H. Cairns.

Braun-Electra-Automatic Weighing Machine Company, Jersey City, N. J., has been incorporated to manufacture weighing machines, etc. Capital, $375,000. Incorporators, W. F. Braun, H. O. Coughlan, S. A. Anderson.

Witthoefft Collapsible Steel Form Company, Jersey City, N. J., has been incorporated to manufacture collapsible steel and other forms, molds, etc. Capital, $1,000,000. Incorporators, H. O. Coughlan, S. A. Anderson, J. R. Turner.

The Buffalo Taxicab Company, Buffalo, N. Y., has been incorporated to manufacture, sell, rent automobiles and operate garage. Capital, $200,000. Incorporators, W. B. Ford, S. S. Olds, Jr., Detroit, Mich. W. A. Morgan, Buffalo.

The Premier Safe Company, Brooklyn, N. Y., has been incorporated to manufacture metallic safes. Capital, $10,000. Incorporators, Peter Gunthy, Union Course, L. I., Harry Stoddard, Greenwood avenue, Borough of Queens. R. T. Raemussen, Hollis, L. I.

New Catalogs

Slack Manufacturing Company, Springfield, Vt. Folder illustrating and describing abrasive metal cutter.

The Nappanee Iron Works, Nappanee, Ind. Folder illustrating and describing Victor punches and shears.

Southern Stamping and Manufacturing Company, Nashville, Tenn. Booklet describing product. 10 pages, 3½x6 inches.

E. G. Smith Company, Columbia, Penn. Bargain bulletin No. 5 and folder explaining clubbing proposition to obtain calipers.

C. W. Hunt Company, 45 Broadway, New York. Catalog No. 091, describing coal- and ore-handling machinery. Illustrated, 88 pages, 6x9 inches, paper.

Shepard Electric Crane and Hoist Company, Montour Falls, N. Y. Bulletin No. 502 describing cranes and hoists. Illustrated, 4 pages, 9x11 inches.

Baldwin Locomotive Works, Philadelphia, Penn. Record No. 66, describing smoke-box superheater and feed-water heater. Illustrated, 32 pages, 6x9 inch.

The "Lomg-Arm" System Company, Cleveland, Ohio. Bulletin No. 27, describing 1909 horizontal model automatic tooth chamfering attachment. Illustrated, 8 pages, 6x9 inches.

The Bristol Company, Waterbury, Conn. Bulletin No. 104, being a "preliminary" bulletin of recording gages for pressure and vacuum. Illustrated, 40 pages, 8x10½ inches.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

A large foundry and machine shop desires to add to present lines of manufacture. Box 126, AMERICAN MACHINIST.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—To manufacture, in modern fireproof machine shop, small specialties in brass or iron. Box 273, AMERICAN MACHINIST.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Wanted—From 500 to 1500 horsepower of B. & W. water tube boilers in units of 250 horsepower each. Must be in A-1 condition. Inquire of J. F. Cargill, Room 1630, Frick Building, Pittsburg, Pa.

To Trade.—One 12"x18" self-contained slide-valve engine for an engine lathe. Shartle Bros. Machine Co., Middletown, Ohio.

If you have a tool or similar device which you wish to sell or have manufactured on royalty, address Box 289, AMERICAN MACHINIST.

Special machines designed and built, estimates furnished; inventions developed to a practical and commercial basis. Benj. Brownstein, mechanical engineer and expert designer, Gundling Bldg., Trenton, N. J.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Factory accountant and systematizer desires to install and supervise a system of factory accounting which will produce advantageous results. Box 296, AM. MACH.

Position as foreman or superintendent wanted; thoroughly up-to-date; accustomed to accurate and intricate work; 15 years with one of the largest manufacturing establishments in the East; satisfactory reasons for changing; New York or vicinity preferred. Box 233, AM. MACH.

MASSACHUSETTS

Practical mechanic; broad experience as general foreman and superintendent; good executive ability; has thorough knowledge of modern shop practice; the use of high-speed steel and interchangeable manufacture; American; 35. Box 282, AMERICAN MACHINIST.

NEW JERSEY

Mechanical engineer, chief draftsman and designer; experienced in steam engineering and pumping machinery, is open for responsible position. Box 301, AMER. MACHINIST.

NEW YORK

Superintendent of large successful concern desires change. Box 235, AMER. MACHINIST.

Mechanical draftsman wishes position; 4 years' experience; also shop experience. Box 295, AMERICAN MACHINIST.

Machine shop foreman, a first-class machinist, toolmaker and all around man in all branches. Box 284, AMERICAN MACHINIST.

Machine patternmaker with 15 years' experience wants a position in an open or non-union shop. Box 300, AMERICAN MACHINIST.

Draftsman, 16 years' experience in marine, stationary, pumping and refrigerating machinery, desires position. Box 293, AM. MACH.

Mechanical engineer; 36 years of age; ambitious, hard working, wide experience in machine shops and drafting room, wishes responsible position. Box 292, AMER. MACHINIST.

Designer, 10 years' experience, fine apparatus, experimental work, special machinery, fixtures; graduate mechanical engineer; hard worker, very capable, inventive. Address Box 297, AMERICAN MACHINIST.

Up-to-date mechanical engineer with 12 years' experience in designing and manufacturing fine and general machinery, also tools; wants to change. Willing to go anywhere. Box 285, AMERICAN MACHINIST.

Wanted—By first-class mechanic, well up in modern tool-room and machine-shop practice, position as tool-room foreman or general machine-shop foreman. Can furnish the best of references. Box 302, AMER. MACH.

Designing engineer, 17 years' experience, educated; practical mechanic, expert on automatic machines, both light and heavy, and tools. Capable, original, successful. Any locality. $2500 per year. Box 286, AMER. MACH.

Machine-shop foreman, 37, good executive ability, nine years in present position, desires change; experienced as draftsman, systematizer and cost reducer; can handle men to best advantage; New York City preferred. Box 291, AMERICAN MACHINIST.

PENNSYLVANIA

Tool and diemaker with broad training on all kinds of tools, long experience in sheet-metal work; also experimental work; could handle men to advantage. Box 298, AM. MA.

First-class all-round machine hand wants responsible position as lathe- or boring-mill hand; capable of handling gang of men with good results. Box 290, AMERICAN MACHINIST.

Mechanical superintendent or shop manager; technical graduate; eight years' practical experience in pattern, foundry, forge machine work and superintendent of construction; age 30. Box 294, AMERICAN MACH.

Mechanical engineer, 31 years of age, of established reputation, technical education, 12 years' experience as designer, chief draftsman and superintendent. Expert on special machinery. Experienced and qualified to direct work and handle men Understands factory and construction gang organization, shop production and economy. Is open for position as mechanical engineer or superintendent of construction; best of references. Box 232, AM. M.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—Young man who thoroughly understands the tempering of drop-forging dies and tools, also experienced in case-hardening and heat-treating. Address "X. Y. Z.," AM. MA.

CANADA

Wanted—First-class toolmakers and machinists, accustomed to automobile jig and fixture work. Apply Reo Motor Car Co. of Canada, Ltd., St. Catharines, Ont.

ILLINOIS

Wanted—Expert foreman for machine shop of about 100 men in Chicago factory of special machinery. Must have thorough mechanical knowledge and training as well as executive ability. Permanent position with good opportunities to A-No. 1 man. Give full particulars. Box 267, AMERICAN MACHINIST.

Wanted—Chief draftsman for Chicago factory of special machinery. Must have exceptional mechanical knowledge and experience, as well as ability to arrange work to best advantage and accurately check drawings. Permanent position with good opportunities to first-class man. Give all particulars. Box 266, AMERICAN MACHINIST.

INDIANA

Two experienced foremen for machine and assembling rooms, manufacturing gasolene motors. Give reference, experience and age. Box 262, AMERICAN MACHINIST.

MARYLAND

Wanted—Three or four first-class draftsmen on heavy machinery and marine engines. Box 247, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—At Leominster, Mass., mechanical draftsman with experience in hydraulic and general line of machinery; state age, nationality, technical and practical training, previous employment and salary expected. Address Box 152, Leominster, Mass.

First-class, experienced mechanical draftsman and designer, familiar with high-speed steam-engine design, wanted for permanent position in large manufacturing concern in Massachusetts; give full particulars as to age, education, experience and salary expected. All information will be treated as confidential. Address Box 299, AMER. MACH.

MICHIGAN

Wanted—A few first-class toolmakers on small work; good wages and steady employment for competent men. Box 278, AM. MA.

Wanted—A man capable of handling a screw-machine department of about 40 machines, consisting of National-Acme automatics, Jones & Lamson and hand screw machines, to act as assistant foreman. We want a man who has had good practical training on a good class of work. Will pay good wages. Box 230, AMERICAN MACHINIST.

MINNESOTA

Wanted—First-class salesman, calling on machine shops, to sell as a side line, a speed shifter just patented. Can be easily attached to any machine at a very small cost. Is highly recommended by those who have installed them. Address Diamond Speed Shifter Co., 1728 2nd St., No., Minneapolis, Minn.

MISSOURI

Wanted—Machine tool salesman of some experience capable of handling a general line of tools and equipment. Box 263, AMER. MACH.

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Aeroplanes of Aerial Experimental Association

Details of Four American-built Machines—All Have Flown—The Last Made a Single Flight of 19 Miles at a Rate of over 40 Miles per Hour

BY G. H. CURTISS*

Prof. Alexander Graham Bell's interest in aviation dates back 17 years. It was greatly increased by his intimate friendship with Professor Langley, and though Langley was ridiculed by the newspaper world for reasons unnecessary to mention here, Doctor Bell saw from Langley and other experimenters that aërial flight was not a science to be ridiculed and thought lightly of, so he decided to enter further into the field by personal experimenting. With this end in view, his beautiful home, "Beinn Bhreagh," near Baddeck, Nova Scotia, became, one might almost say, a human nest with the surface of Bras D'or lake as a field of flight.

His interest in the new work was greatly appreciated by his gracious wife, Mrs. Bell, who became so fascinated with it that, later, her influence and financial support brought the Aërial Experiment Association into being, and started it upon its great work.

Doctor Bell, who is much loved by the younger set and believes firmly in giving the young man a good start, took with him in his work, J. A. D. McCurdy, who brought with him a personal friend and engineer, F. W. Baldwin, of Toronto, Canada. These three, backed by Mrs. Bell, started at work, in Baddeck, on Doctor Bell's tetrahedral kite, first making models which were flown with good results, and later a man-carrying kite on the same lines.

As this point the American public became interested. Articles were printed in the American press and Doctor Bell, seeing the progress made, informed the American Government of their intention to fly a man-carrying kite which, if successful, would be of great value to the War Department, etc. At the same time he inquired if the Government did not wish to have a representative present. As a result, the late Lieut. Thomas E. Selfridge, First United States Field Artillery, was recommended and sent to Baddeck to gain all possible information. During the following few months many tests were made with different forms of kites, principally with tetrahedral cells. Unique experiments were also carefully and tenderly made by holding a cat by its paws at a certain hight, dropping it suddenly and studying what part gravity played with a cat's movements, which invariably land it feet first. Many different forms of trussed frames were worked out and tried, to get the least resistance with the greatest strength and lightest weight. Also racing hulls for catamaran structures were made for carrying larger kites; air-filled floats for pontoons were rigged up—all to gain speed while getting under way.

The combined knowledge obtained from these minor experiments helped to construct the larger man-carrying, tetrahedral kite, "Cygnet," composed of 3393 cells, covered with 184 square feet of silk. On December 6, 1907, this aërodrome, attached by a tow-line to a steamer making 8 knots, rose gently from the water and carried Lieutenant Selfridge 168 feet into the air. Owing to a strong breeze, which unfortunately blew the smoke from the steamer directly into the path of her charge, the view of those handling the flying line was obliterated. They were supposed to cut the line as soon as the kite started her downward course in order to gain knowledge of her soaring capacity. Failure to cut the tow-line in time caused the kite eventually to be dragged through the water and subsequently wrecked. However, most important data were obtained by Aviator Selfridge.

These experiments showed clearly the possibilities of a power-driven machine, if a light, powerful, and above all, a reliable motor could be obtained; at that time such a motor was unknown to these four workers. A search showed that an aërial motor had arrived in time to further their

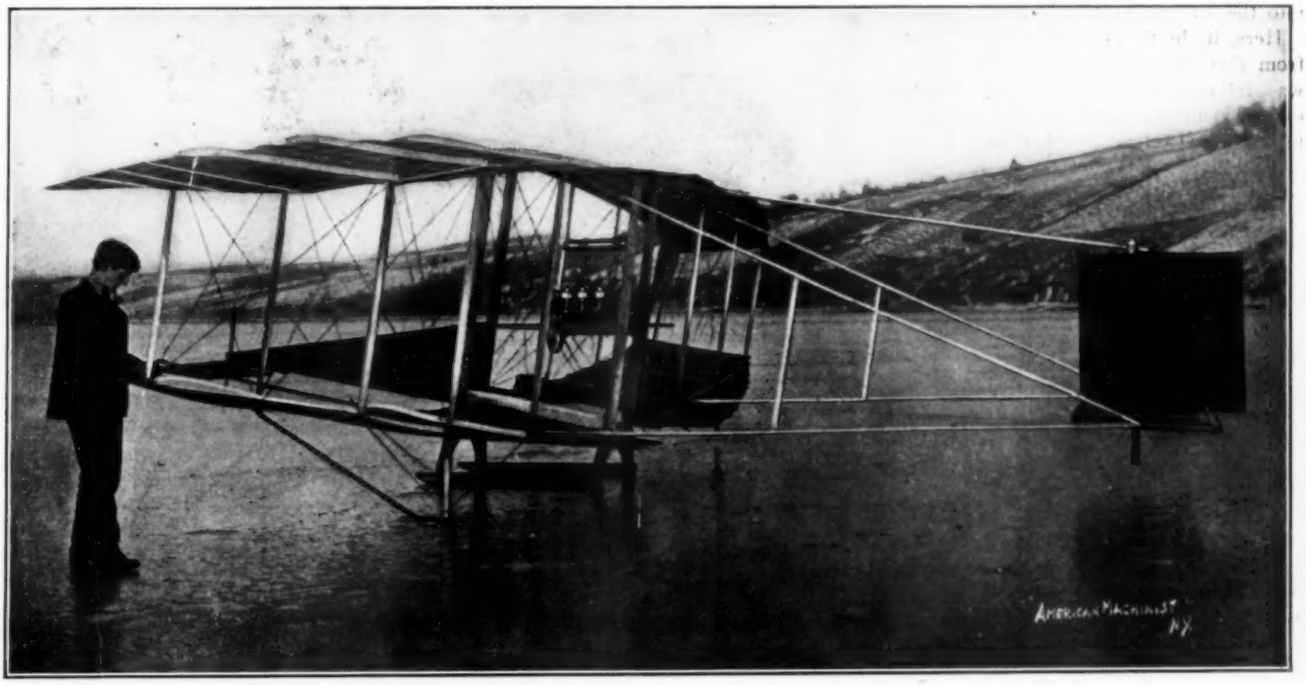


FIG. 1. THE "RED WING"—FIRST AEROPLANE BUILT BY THE AERIAL EXPERIMENT ASSOCIATION

*Director of experiments of the Aerial Experiment Association.

experiments, in the type built by me at Hammondsport, N. Y., and used successfully for several years in motorcycles. At this time aërial navigation was no new subject to me, for during the preceding four years the people of Hammondsport had witnessed flights by Capt. T. S. Baldwin in his dirigible baloon, who, in all of his 3000 trips through the air used, and still uses, my motor.

Personnel of the Aerial Experiment Association

Other inventors have made futile attempts in Hammondsport to fly with heavier-than-air machines, but the glory of the first public flight in America awaited the Aërial Experiment Association, which was formed October 1, 1907, with the following members: Dr. A. G. Bell, president; G. H. Curtiss, director of experiments; Lieut. T. E. Selfridge, secretary; F. W. Baldwin, chief engineer; J. A. D. McCurdy, treasurer.

Mrs. Bell's offer to furnish funds for the promotion of experiments with the purpose of putting a practical aërodrome into the air was gratefully accepted.

Here, it should be said, a line different from that used in the early experiments was followed by the members, with the exception of the president, who continues to work with tetrahedral cells. It was

FIG. 2. TYPICAL FISH-SHAPED SECTIONS

arranged that each member of the association should build a machine after his own idea and design and to be called his property. Lieutenant Selfridge, probably at that time the best informed aëronaut in the country, with a most brilliant future to look forward to, was the first to be chosen to build a machine after his fancy. Having read and studied extensively Lilienthal's, Chanute's, Maxim's and many other forerunner's methods, he decided to build his, the "Red Wing," closely following the plans of these inventors.

During the construction of the "Red Wing" several forms of gliders were made for the purpose of studying the equilibrium of aëroplanes. These were successfully tried on the surrounding hills of Hammondsport during the winter of 1908; many long glides were made above the snow with but a few minor mishaps.

The gliders, biplane type, were similar to those used by the above mentioned aëronauts, that is, a simple, box-shaped frame securely trussed with piano wire. Fish-shaped struts were used throughout to cut down resistance. The surfaces, top and bottom, were of fine-meshed linen of light weight. The length of the gliders was 25 feet, width fore and aft, 5 feet, hight of struts, 5 feet. Protruding outward in front was a bamboo structure carrying the control, by which, at will, the operator could raise or lower the glider while traveling through the air. Much knowledge was gained with these first attempts at flight, also much pleasure.

The Aeroplane "Red Wing"

By March 11, 1908, Aërodrome No. 1, Selfridge's "Red Wing," was ready for trial, built on lines similar to the gliders, with double superposed surfaces, and in the class generally known as the "Chanute type." There were two distinctive features in this design. The first was in the general principle and arrangement of the truss which supported the two surfaces, and the second in the shape of the surfaces themselves.

The frame of the usual double decker

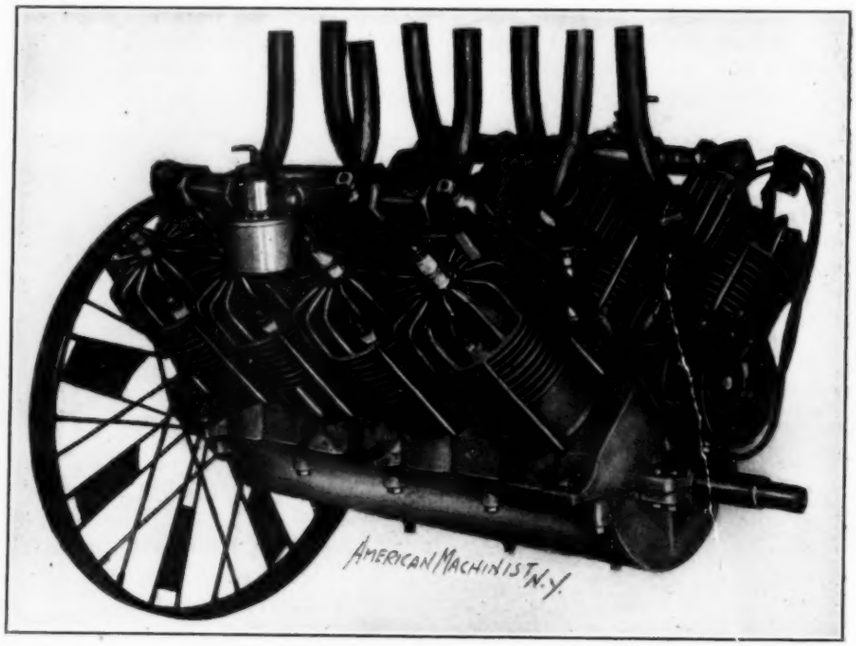


FIG. 3. TYPE OF MOTOR USED IN FIRST THREE AEROPLANES

is the simple Pratt truss, with parallel upper and lower chords and panels of consequently constant depth. The vertical posts in this form of truss are held at two points only—top and bottom.

In the "Red Wing" truss, see Fig. 1, the upper and lower chords were made converging toward their extremities, giving the panels greater hight in the center where the bending moments are at a maximum, and gradually decreasing in hight toward the outside panels where the bending moments approach zero. In this way the hight of the truss was proportioned to the bending moments; and as the stresses due to bending are by far the greatest ones to be considered, the structural advantage in having the chords bowed is obvious.

Another equally, if not more important feature was the lateral support afforded to the vertical posts of the truss by attaching them to bow-string wires extending from tip to tip of both the upper and lower chords. This fixed the uprights against lateral deflection at four points and theoretically increases their efficiency about four fold over two-point support.

The great advantage in this is that beside lending itself naturally to lighter construction, it permits the use of struts very narrow in cross section, thus materially reducing the head resistance offered by the frame work. All the exposed members of the main planes, tail and bow control, which were substantially at right angles to the line of flight were made of a fish-shaped cross-section, giving a form of least resistance according to experiments made by Professor Zahm and conforming fairly well to stream-line theory. A number of different sizes of spruce sticks were made for this purpose. They were of four to one, and three to one dimensions, the largest size being 4x1 inch and the smallest 1½x½ inch, see Fig. 2.

Another feature of the "Red Wing" was the shape of the supporting surfaces. These were very much like a bird's wing in plan, tapering toward the tips and at the same time decreasing in curvature. Experiments published by W. R. Turnbull suggested the advisability of using aëro-surfaces concave below in the forward position and convex in the after position. The double curvature of the surfaces was obtained by the use of curved ribs each made up of four laminations of wood ⅛ inch thick. The outside strips were of ash, to give the required stiffness, and the inner ones of spruce. These strips were laid up on a form carefully glued together and pressed. They retained their

shape admirably without any apparent warping.

The spread of the wings from tip to tip was 43 feet, 4 inches. The depth of the surfaces at the center was 6 feet 3 inches, and the distance apart 6 feet 6 inches at the center, and 4 feet at the outside panel. This gave a combined surface of 385.5 square feet.

The seat for the operator was arranged just above the lower surface in the control panel. His body was shielded by a rectangular, spindle-shaped nose, which was covered with silk and came to a point seven feet in front of the main planes. This nose was made of four bamboo poles with internal bracing and supported the bow control, which was a flat surface 5 feet across and 2 feet deep. It was balanced about a point one-third back from its front edge and pivoted at the point of the nose, 7 feet in front of the main planes. Yoke-ropes connected the bow control to the steering drum just in front of the operator at his left-hand side, and was manipulated by turning the drum by a small spoke attached to it.

Fore-and-aft stability was also sought by the use of a fixed small-surface tail. It was 14 feet, 10 inches across and 3 feet deep giving a surface of 44.5 square feet. This surface was placed horizontally 10 feet back of the rear edge of the main planes and was attached by bamboo poles guyed with piano wire. Right and left steering was effected by a square rudder 4 feet by 4 feet, which pivoted about a vertical axis above the tail and was controlled by steering ropes which led to a lever just in front of the operator at his right-hand side.

While there were no fixed vertical planes in the "Red Wing," the fish-shaped uprights of the main truss offered a vertical surface calculated as 19 square feet.

As the experiments with this machine were to be conducted over the ice, it was mounted on runners. Two main runners with a tread of 2 feet 6 inches were placed below the center panel and supported nearly the entire load of the machine. A light runner was fixed under the tail and subsequently taken off as the machine retained its balance on the front runner alone. Two light runners were also placed under the second panels from the center in case the machine should come down sidewise in landing.

The main planes were given an angle of incidence of 7½ degrees. The engine used was an eight-cylinder Curtiss, air-cooled motor. The bare engine weighed 148 pounds, but with the oil tank, batteries, shafting, coil, etc., it weighed about 185 pounds. See Fig. 3.

The propeller was made of steel; had two blades; a diameter of 6 feet, 2 inches, and a pitch of about 4 feet. It weighed 15 pounds and was driven direct; the engine and shafting were mounted horizontally. The fundamental idea in the design of the "Red Wing" was to produce an aëroplane with head resistance reduced to a minimum and power enough to insure its getting into the air. The entire weight of the machine was about 500 pounds.

Flights of the "Red Wing"

On March 12, 1908, this machine was successfully flown over the ice on Lake Keuka, near Hammondsport, in the presence of many witnesses. This experiment was important as being the first successful public flight of a flying machine in America, the earlier flights of the Wright brothers at Dayton, Ohio, having been made in secret.

The machine, carrying as operator F. W. Baldwin, glided over the ice for about 100 feet before it rose in the air. It then flew very steadily at a general elevation of from 10 to 20 feet and landed 319 feet distant. On March 13, other short flights were made. On the 17th the "Red Wing" came to an untimely end by an accident which completely demolished the machine, although fortunately the aviator and the engine escaped uninjured. The association then immediately began the construction of aërodrome No. 2, Baldwin's "White Wing."

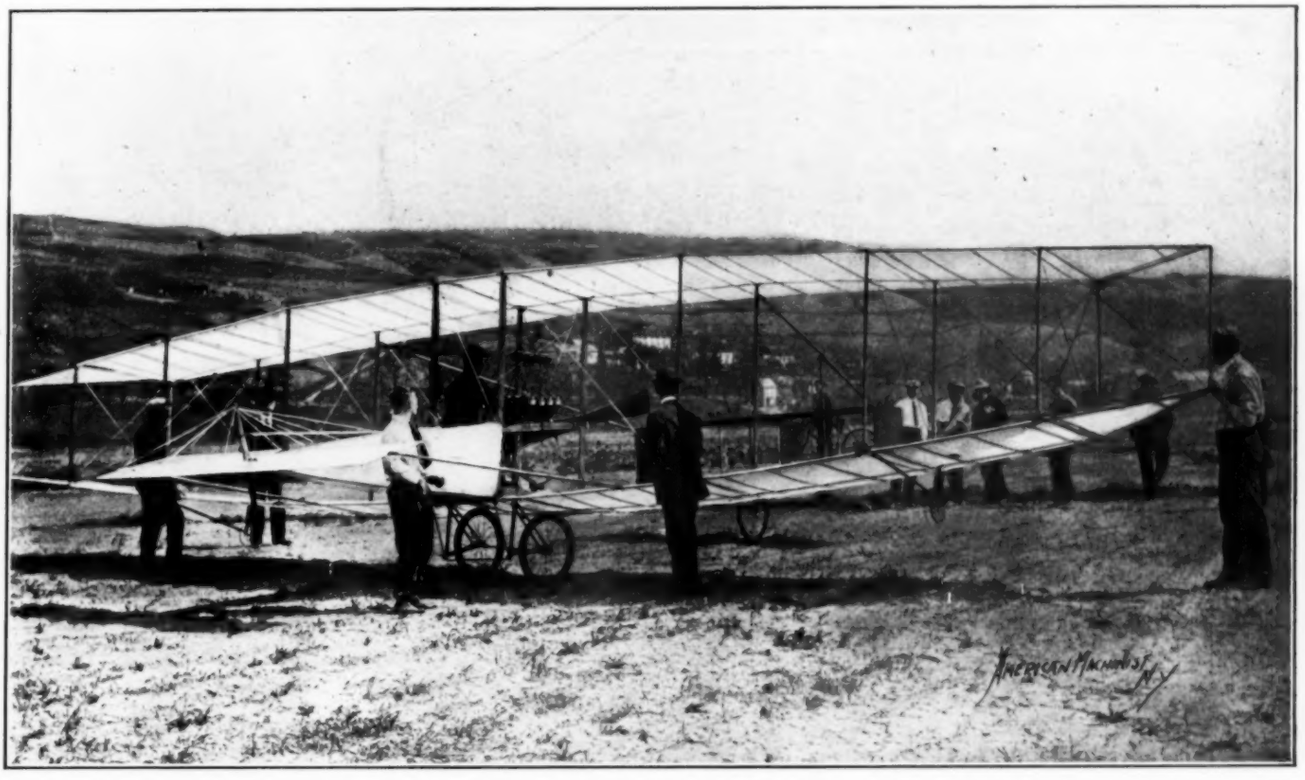


FIG. 4. THE "WHITE WING"

The middle of May saw this machine take the field. After the breaking up of winter the experiments were continued about two miles up the valley from Hammondsport, where a large tract of farm lands furnishes magnificent facilities for the enormous soaring bird.

The "White Wing"

The "White Wing," though a reproduction of the "Red Wing" in general design, as shown in Fig. 4, differed considerably. It was built of heavier materials throughout and with slightly larger

surfaces; the improvements were nearly all in details of construction.

In this machine it was deemed advisable to get some positive method of controlling the lateral stability. The tips at the extremities of the wings were hinged about their fore edges, and by a system of steering gear, the angles of incidence could be changed by the operator. By this arrangement if the machine inclined to one side the aviator by leaning to the high side operates a tiller connected by steering ropes and increases the angle of incidence of the tips on the lower side and decreases the angle of incidence of the tips on the high side. This gives a righting couple, which should keep the machine on an even keel, the idea being that the man will instinctively lean to the high side.

The bow control was placed a foot farther in advance of the main plane than in the "Red Wing," and was 9 feet across and 2.5 feet deep. This control was operated by a lever connected directly to the steering post, and not by yoke ropes as in the case of the "Red Wing."

Right and left steering was provided for by a triangular rudder which swung about a vertical axis behind the after central strut of the tail. The steering ropes from this rudder led to the steering wheel in front of the operator, which worked like the steering wheel of a motor car, turning to the right put the rudder over to the right, and turning to the left put the rudder over to the left.

The tail was composed of two superposed surfaces giving about the same surface as in the "Red Wing," and was placed 10 feet (the same distance) behind the main plane. This was done to remedy the weakness shown by the faulty construction of the single surface tail first used on the "Red Wing." The box, which constituted the tail, was given a slight angle with the engine bed (1 in 27, or 2 degrees 20 minutes). In this it differed from the "Red Wing" in which the tail was parallel with the engine bed. The justification of this, by no means unimportant, departure was that theoretically it seemed that the machine when perfectly balanced should have all its surfaces, including controls, at the most efficient angle, i.e., the angle at which the ratio of lift to drift is greatest.

In this machine all members of the truss outside of the center panel fitted into sockets and were thus more easily repaired than in the old construction with its through members. The uprights were fitted with a set screw in the socket so that they might be lengthened out or shortened, thus doing away with the necessity for turn-buckles on the diagonal wires. A wooden propeller was used on this machine with the same engine as before. The diameter was 6 feet, the pitch was slightly less than the diameter. The weight of the propeller was about 8 pounds, and it proved more efficient in every way.

This new machine was 43 feet 6 inches from tip to tip; the planes were 6 feet 6 inches deep at the center and 4 feet deep at the outside panel, which gave a total supporting surface of 408.5 square feet. The weight of the main planes with the engine bed was 133 pounds as against 119 pounds in the "Red Wing." The nose weighed 27 pounds, the tail, including a light wheel, weighed 30.5 pounds. The wheels and the spring frames which supported them weighed 47 pounds. The engine, accessories and propeller weighed 192 pounds. Thus the total weight, taking the man at 175 pounds, was about 600 pounds. This gave a flying weight of about 1½ pounds per square foot, comparable with 1¼ pounds in the "Red Wing."

The cloth used throughout (except for the tail, which was silk) was of a quality of nainsook which weighed 70 grams per square meter (2.25 ounces per square yard). Altogether the new machine was a great improvement over the old one in the matter of construction. While its struts were larger, more of its members were inclosed, and, therefore, did not offer much more head resistance than the "Red Wing."

Flights of the "White Wing"

On May 17, 1908, the "White Wing," ready for her preliminary trial, was taken to the race track two miles up the valley and the aviator's seat was occupied by Lieutenant Selfridge. No attempt, however, was made to get into the air. The machine had been provided with wheels, but steering gear was not attached to them, as it was thought that the aërial rudder would control the movements of the machine while on the ground. This proved insufficient for the purpose, for the machine could not be kept from running off the track. It was, therefore, decided to provide it with steering gear so as to enable the operator to keep the track for a distance long enough to gain sufficient speed to get into the air.

On May 18, this aërodrome made a short flight carrying its designer, F. W. Baldwin, to a hight of 10 feet. The pressure of the air on the elastic rear edge of the lower aëroplane caused it to foul the propeller. The machine was brought to the ground after having traveled a distance of 93 yards. On May 19, Lieutenant Selfridge made two flights. In the first experiment the machine ran 210 feet in

FIG. 5. FRONT VIEW OF THE "JUNE BUG"

6½ seconds on the race track before leaving the ground, and made a flight of 100 feet in two seconds at an elevation of three feet, and ran 201 feet on rough ground after landing without injury to the running gear. The flight was impeded by loose guy wires catching in the propeller; no damage resulted. In the second experiment the machine made a beautiful and steady flight of 240 feet at an elevation of at least 20 feet in the air, but landed badly in a newly ploughed field, breaking the front wheel. The engine had abundant power, and the machine was under good control in the air.

On May 21, I made a flight of 339 yards (1017 feet) in the "White Wing." The machine was under perfect control at all times and was steered first to right and then to left before landing. The 339 yards was covered in 19 seconds, or at the rate of 37 miles per hour.

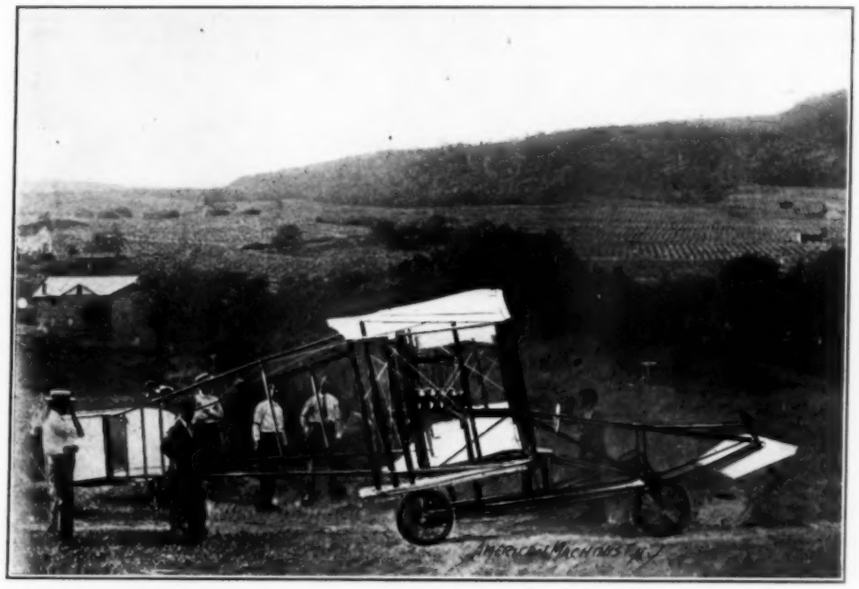


FIG. 6. SIDE VIEW OF THE "JUNE BUG"

On May 23, J. A. D. McCurdy handled the "White Wing" in her fifth flight; 183 yards was covered in 10 3/5 seconds at a rate of 35 miles per hour maximum hight, 20 feet. Quite a strong quartering wind was blowing which Mr. McCurdy did not allow for with his lateral controls, this being his first trial. This caused the machine to careen and strike her right wing. She turned turtle, pivoting on the nose, and finally rested on her top plane with engine and wheels in air. The center panel was so strongly built, however, that it remained intact; the engine staid fast in its bed. Neither operator nor engine were in the least injured. The machine, itself, however, was quite badly damaged and rather than repair, a new machine was started.

This, the fifth flight made by the "White Wing," completed a total of 674 yards in the air; Baldwin, 40; Selfridge, 112; Curtiss, 339 and McCurdy, 183 yards. A grand total traveled by the two machines since March 11, in seven flights, summed 821 yards.

The "June Bug"

Aërodrome No. 3, Figs. 5 and 6, was built after my plans and specifications and was later christened the "June Bug." The wing tips were so set that when not in use they were at a neutral angle, while those in No. 2, when not working as controls, were parallel to the surfaces. The gearing of the wing tips was simplified by the new arrangement of wiring necessitated by the operator's seat being moved farther to the front.

The main weights were separated by a greater distance in No. 3 than in No. 2. The engine was set five inches farther back and the man two feet farther to the front. The front control was also moved farther out; its front edge was 10 feet 10⅛ inches in front of the front edge of the main planes, thus making the machine 27½ feet long. Five square feet were added to the area of the front control, its total spread being 13 feet 10 inches, as compared with the 11 feet 8 inches of No. 2. The nose was wedge-shaped instead of pointed and left uncovered.

The running gear consisted of three wheels as before, but the wheel base was extended two feet. It was greatly strengthened by two large wooden members running fore and aft, which were to be used as skids in case the wheels broke in landing. The wings were made so that they could be easily removed from the engine-bed section and their surfaces were varnished with a mixture of yellow ochre, paraffin and turpentine in order to make them air tight. The yellow ochre was used to give a color to the surfaces to facilitate photographing the machine in the air, the "White Wing" having proven a very poor subject when photographed with the sky as a background. The working surfaces of the machine were reduced from 408 to 370 square feet. The switch and spark controls were placed on the front steering wheel. The lower plane was greatly strengthened by eight guy wires fastening it to the hubs of the wheels and bottoms of the skids.

The engine section was made up of lighter material; the struts were only ¾ of an inch thick at their widest part and 3¼ inches long, instead of one inch thick at their widest part and 4 inches long, as used in No. 2. Additional guy wires were added to this section, which made it more rigid than before. The propeller was cut down from 6 feet 2 inches to 5 feet 11 inches, which allowed the engine to turn about 1200 instead of 1050 revolutions per minute.

The tail was made spar-shaped from side to side, to conform to the general shape of the main surfaces. The vertical surfaces of the tail were removed and the area of the vertical rudder increased from 27 to 36 inches square. The distance between the center of gravity of the operator and the center of gravity of the engine was 6 feet.

Aërodrome No. 3 was "born" in June and ready for trial June 19, hence the name "June Bug." On the above date tests were made of the running gear and surfaces. The former engine not having been injured by accidents in the other two machines, was placed in the "June Bug."

At this juncture a change took place. The "June Bug" was the outcome of previous experiments, which were now no longer experiments, but a case of flying at will in the straight away, though many trials were undertaken before it was learned how to return to the starting point without landing. From small jumps of a few hundred feet flights of 2 and 2½ miles were now successfully made under absolute control at all times. Landings were accurately studied out, etc.

First Flights of the "June Bug"

The first flight of this aërodrome occurred on June 21, 1908. I covered a distance of 456 feet at the rate of 28.1 miles per hour; the second was 417 feet at the rate of 31½ miles per hour, and the third 1266 feet at the rate of 34 miles per hour. This last flight (all three were made on the same day) was the longest ever made in public in America at that time. On June 25 another record flight was made of 725 yards (2175 feet) at an elevation of 40 feet; time, 41 seconds; wind, 8 to 10 miles an hour blowing with the machine. The same day witnessed a still longer flight of 1140 yards (3420 feet) in 60 seconds.

Such success had followed this machine

that the association telegraphed the secretary of the Aëro Club of America that they were ready to try for the *Scientific American* cup, and arrangements were made for a trial to take place on July 4 at Hammondsport. On July 3 I made a practice flight of ¾ mile to prepare for the following day. A good view of the machine in full flight is shown by Fig. 7.

Winning the First Aeronautical Prize in America

On July 4 the small town of Hammondsport was crowded with spectators from all parts of the country to witness the flight of the "June Bug" for the trophy. The distance to be covered had to be at least 1 kilometer (3280 feet). The day broke with very unfavorable conditions of rain and a severe wind. Late in the afternoon the rain ceased and the banks around the race track, the adjoining fields and the grounds themselves were crowded with enthusiastic sightseers. Toward 5 o'clock the weather cleared, the wind dropped and the "June Bug" was brought from her tent to the starting point on the half-mile track on Stoney Brook Farm, where the testing grounds are located. With a turn of the propeller the engine was started, the assistants released the machine and she sped down the track for a distance of 150 feet and glided gracefully into the air and out over the fields.

As the "June Bug" neared the finish she gradually settled toward the ground and finally landed 100 yards short of the mark. The assistants rushed to the spot and the machine was wheeled back to the starting point. She lost headway through the necessity of keeping the front control hard down to prevent her going too high. The cause was soon located. The tail, which was adjustable, had been fitted in the wrong notch and at a slight negative angle. This naturally caused the machine to have a tendency to rise higher, and when offset by the front control so great a head resistance was brought to play that the propeller did not furnish speed enough to keep her in the air.

After adjustment a second start was made. The "June Bug" rose in the air at once and flew away on her course as if she meant business. She not only passed over the flag, but was guided over the fields, fences, ditches, etc., as far as possible without going above the telegraph wires and trees, which obstruct this part of the valley. A good landing was made after covering something over 1¼ miles.

The "June Bug" had won the trophy, the first aëronautical prize to be offered in America.

About this time Doctor Bell and Mr. Baldwin left Hammondsport for Baddeck to continue work on tetrahedral cells. Headquarters of the association were still retained in Hammondsport and almost daily flights with the "June Bug" were made by Mr. McCurdy and Lieutenant Selfridge.

Although the "June Bug" had gained more credit than I could have anticipated, she was kept in commission, and a number of important experiments were made in connection with control and stability. I had made some 20 flights before the trial for the cup, but no serious damage had resulted in the landings. A few struts had been broken and replaced, but the "June Bug" was still in excellent condition.

Tail Surfaces Unnecessary

The first experiment consisted in removing the surfaces of the tail. This was done one surface at a time and, although control was more difficult at first owing to the sensitiveness of the front control and the inclination of the machine to pitch, the tailless aëroplane was considered an improvement. When it was decided later to build a fourth aëroplane, known as McCurdy's "Silver Dart," the plans were drawn without a tail. It was also decided to build a new engine of greater horsepower and water cooled.

Several months elapsed before the machine and engine were completed. The "Silver Dart" measured 49 feet from tip to tip. The front control was placed farther forward and no tail was used. This change made quite a difference in the controlling of the machine, making it most sensitive to the action of the forward control. In fact in the first few flights, until the operator learned the sensitiveness of the control, the flight was in a wavy line, first shooting upward and then darting downward. This, however, was overcome after the aviator had gained experience with the machine.

August 8 saw the Hammondsport division of the association grow even smaller. Lieutenant Selfridge was called to Washington for the purpose of giving his assistance to the war department at the trials of Capt. T. S. Baldwin's dirigible balloon, and for the approaching trials of the Wright Brothers aëroplane.

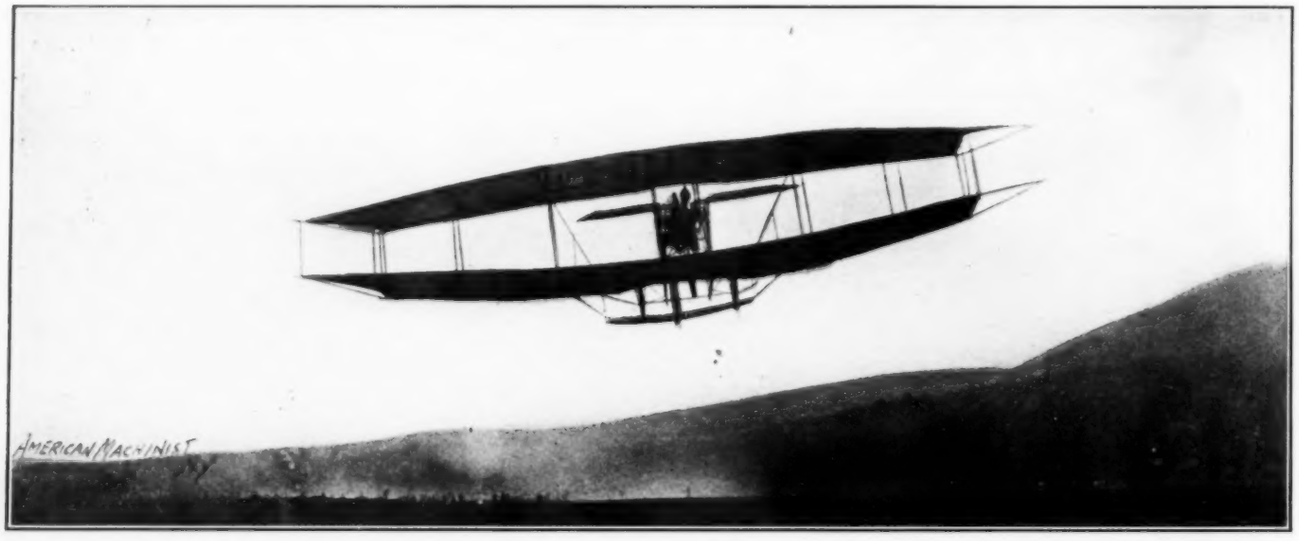


FIG. 7. THE "JUNE BUG" IN FLIGHT

Following the successful Baldwin tests Orville Wright made new aëroplane records, astonishing the world with his flights of an hour or more and proving to all non-believers that the flying machine had arrived. Several times he carried passengers in his short flights.

Loss of an Important Member of the Association—Lieutenant Selfridge

It was during one of these passenger flights on September 17, that a very sorrowful catastrophe occurred; most keenly felt by the members of the Aërial Experiment Association. Previous to starting the flight, new propellers were put on the machine. Lieutenant Selfridge had been detailed to fly with Mr. Wright on this occasion. All went well until the

third circle of the grounds was made when a loud report told the spectators something had happened. One propeller broke and the machine darted to the ground from a hight of 75 feet, turning turtle as she came downward. Mr. Wright was found unconscious with several ribs and one thigh broken; Lieutenant Selfridge was beyond recovery, with a fracture at the base of the skull from which he died two hours later.

The Wright's flyer differed considerably from those of the association, though both are of the biplane type, and by a non-critical observer would be regarded as much the same machine.

The Wright brothers passed through many stages which finally produced their present remarkable machine, beginning their experiments in 1902 by gliders such as were employed by the members of the association in 1907. The brothers worked several years with the gliders alone, before they endeavored to use a power driven machine. After five years' experimenting over the sand dunes of Carolina and near Dayton, Ohio, they finally brought their latest type to Washington.

In this machine the framework is flexible, a necessary feature, in order to permit of distortion, so that the aëroplane may be twisted in accordance with the method of lateral control. In operating the lateral controls, each aëroplane is given a twist along its entire length, so that each aëroplane surface has a helicoidal warp or twist, for the reason that it gives a continuous surface on each side of the machine, which has a gradually increasing or decreasing angle of incidence from the center of the machine to either side. This twisting action is assisted by a steering movement of the vertical rudder at the rear.

Moving the "lateral marginal portions of the aëroplane" is the essence of the Wrights' method for lateral equilibrium. This combination changes constantly the lifting power of their machine. Without the use of the vertical rudder at the rear to counterbalance, their machine would invariably turn in the direction of the distorted frame.

The winged surfaces are square shaped, The front control, a box-like frame, is acted upon by two levers, one to raise, the other to lower the machine.

They use the tail in the rear, thought by many prominent aëronauts to be an essential feature of all bird-like flyers. The landing device is skids, which necessitates a rail with drop weight for starting. Two 9-foot propellers, chain-driven from a 25-horsepower water-cooled motor furnish the power necessary to drive the machine at the rate of 35 miles per hour. The area of surfaces and weight of the two machines compare favorably with each other.

The "Silver Dart"

In reference to the "Silver Dart" of the association a great deal could be said. In the first instance the machine was constructed with all panels separate, making the work of assembling, repairing, disassembling, crating, etc., a very simple matter.

Experiments with the "June Bug" seemed to indicate that more powerful tip controls would be an advantage, especially in attempting to complete a turn and possibly in describing a circle. To accomplish this the machine has a greater lateral extension than in the case of either of the former machines, 49 feet, and also an increased area of the tip controls themselves, 40 square feet total area.

Although it was conceded that a plane having the form of the letter *S* (roughly) in cross-section was the form having greatest efficiency as demonstrated by W. R. Turnbull, the members came to the conclusion that if a rib was formed of single curvature, it would take the form of the Turnbull curve when acted upon by the air pressure as the machine glided through the air, if the rear was unrestricted and flexible; but if the rib was

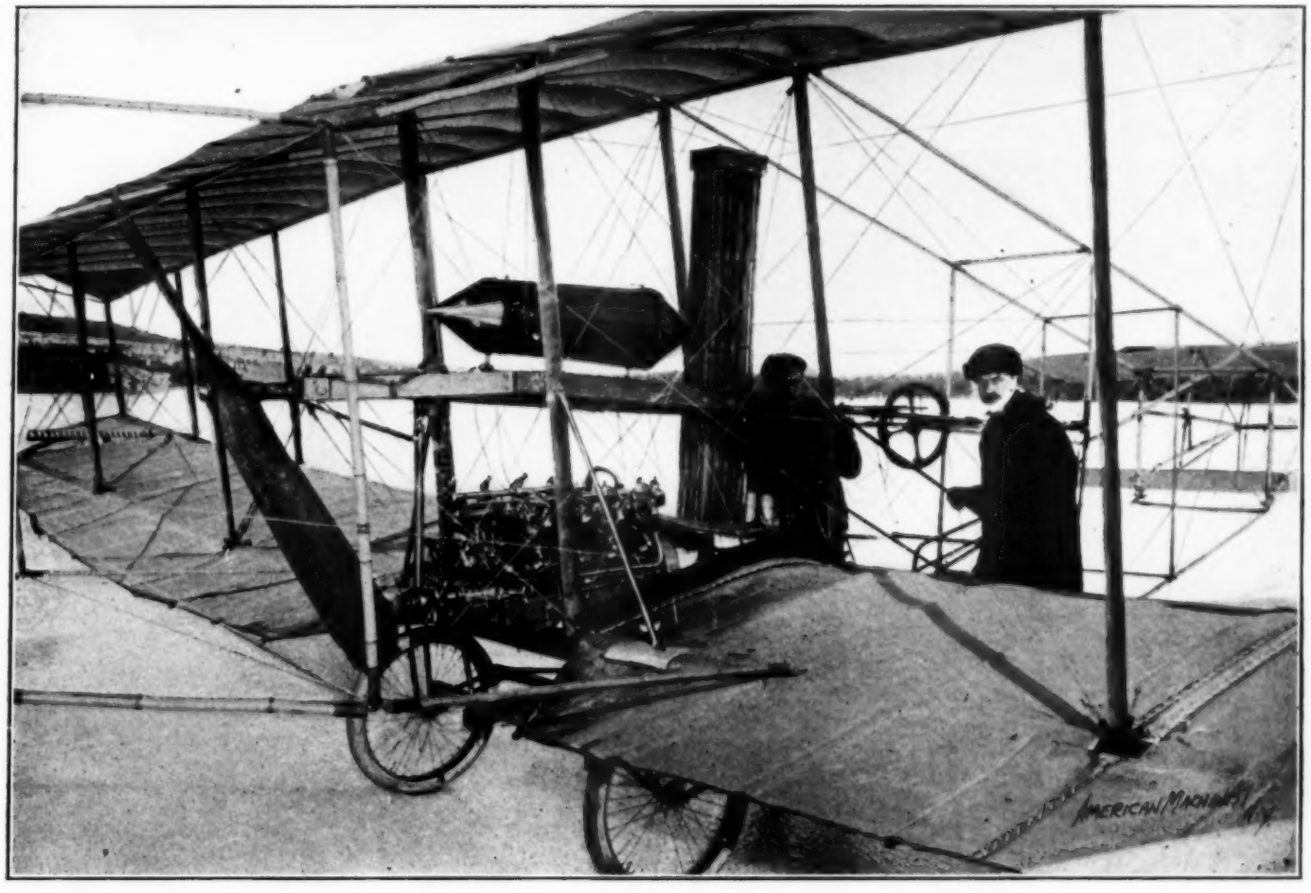


FIG. 8. PARTIAL LENGTHWISE VIEW OF THE "SILVER DART"

molded with the double-curve form the air pressure would bend it up abnormally at the rear and hence produce a detrimental effect. Single curvature ribs were therefore decided upon as shown in Fig. 8.

The depth of planes was reduced at the center from 6 feet 6 inches to 6 feet, and the distance between the planes consequently reduced in the same ratio (6 feet 6 inches to 6 feet). The ends of the supporting planes were designed to have a depth of 4 feet as in former cases, also to be 4 feet apart.

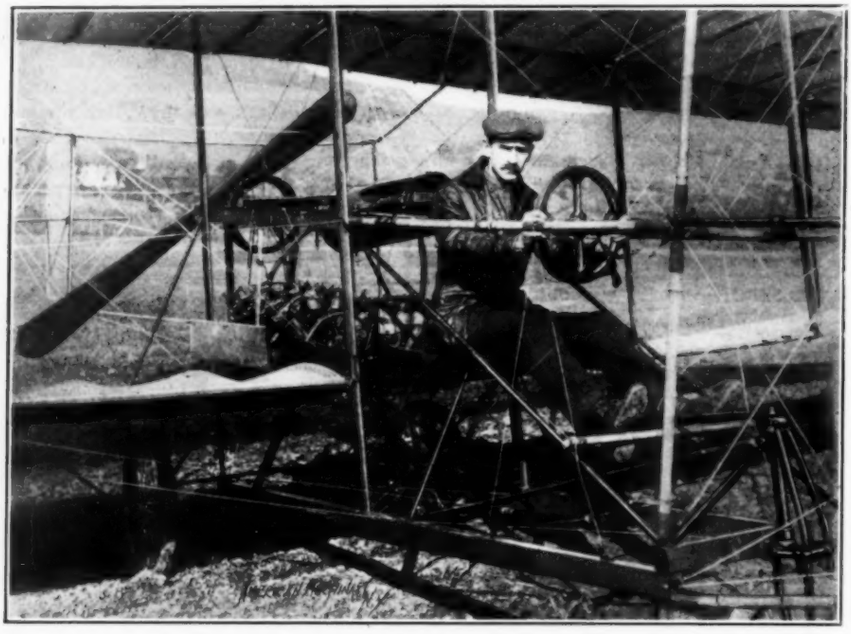


FIG. 9. MAIN PANEL OF "SILVER DART" FROM FRONT

The fish-shaped material used throughout was of heavier stock, hence capable of greater rigidity of structure. Turnbuckles were used on each individual wire, so that they could be separately adjusted to receive their proper strain.

The cloth used to cover the ribs, etc., forming the supporting surfaces, was similar to that used by Capt. T. S. Baldwin for his government balloon, although lighter in weight, 2 ounces per square yard, and having silk on only one side of the rubber coating.

The central panel is made exceptionally strong for various reasons. The bending moments are greatest there, the dead load is located at that point, and the racking strains are more severe there than elsewhere. This panel was made up first and was complete in itself. The four wings, when placed in position, fit into projecting sockets from each side of this panel, and were secured in place by the same method employed throughout the structure; viz., by attaching and tightening up the turnbuckles, thus making assembling most simple.

The silk of the "Silver Dart" is made in sections corresponding to the panel where it was used, and laced to the steel rib at each end. The rudder is of quite small dimensions, 4 feet high by 2 feet deep, and is placed 11 feet back from the rear lateral chord, and supported simply by four hinged bamboo struts, so constructed that by releasing two lateral guy-wires the whole device folds up flat against the rear of the planes. See Figs. 8 and 9. The rudder is operated by small wire cables connected to the tiller of the front wheel. The bow control is double-decked, rigidly constructed throughout and placed 15 feet forward of the front lateral chord. It is operated by a direct bamboo rod at the rear end of which is the steering wheel. Pushing the wheel forward depresses the machine; pull it back and the machine rises; turn it to port or starboard, and the machine obeys respectively whether on the ground or in the air.

The front control measures 12 feet long by 28 inches wide and 30 inches between the planes. It is supported five inches back from its front edge by a bamboo cantilever truss.

It was originally intended to carry two persons in the "Silver Dart," one sitting directly behind the other, hence a seat was designed for the purpose and made adjustable so that it could be slipped forward and backward readily in balancing the machine. The second man would sit directly over the theoretical center of pressure at traveling speed so that the carrying of a passenger or leaving him behind would not affect the balance. The running gear or truck is almost the same as that used in the "June Bug" with improvements of construction and heavier material.

Power Plant of the "Silver Dart"

The engine, Fig. 10, was built especially for this aërodrome and is a Curtiss, eight-cylinder, water-cooled, 50-horsepower motor, with 3¾-inch bore and 4-inch stroke. The cylinders are placed in the form of a V, four on each side. Mechanical valves are used and they were built for durability and constant hard running. The engine alone weighs 175 pounds. It is placed with its bed immediately on top of the lower rear chord, and securely braced. Its low position produces less strain on the structure in landing and brings the center of gravity of

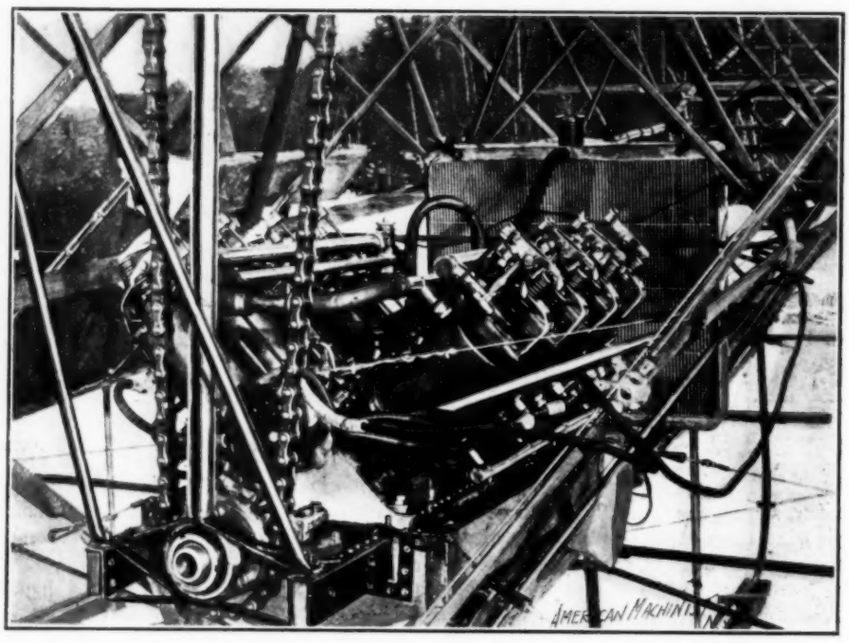


FIG. 10. POWER PLANT OF THE "SILVER DART"

the machine as a whole a little lower than in the case of the "June Bug."

The propeller is chain-driven in the ratio of 1½ to 1; the engine turns 1200 revolutions per minute and the propeller 800. One propeller is used, and the thrust comes through the line of resistance of the machine, but inclined above the horizontal 3¼ degrees. It is made of laminated wood and weighs, including the two clamps, 8¼ pounds; it is 8 feet in diameter and has 17 to 18 degrees pitch at the tip.

The supporting surfaces of the machine are given an angle of attack of 9 degrees at their lateral margins. This angle is excessive for economical flights, but it facilitates rising from the ground. After the machine gains the air the angle changes to 6 degrees. The accompanying table shows the weights, etc., of the "Silver Dart:"

Fish-shaped material:	
Wings	1928.5
Struts	1088.0
Additional	326.0
Total	3342.5
Non-vibrating wires	976.89
Vibrating wires	131.30
Tubing	668.0
Timber	365.5
Bamboo	345.0

Description.	Square Inches.	Co-Efficient.	Equivalent Surface.
Fish-shaped	3342.5	⅙	557.08
Non-vibrating wires	976.89	½	488.44
Vibrating wires	131.3	½	198.95
Tubing	668.0	½	334.0
Timber	365.5	1	365.5
Bamboo	490.0	½	245.0
Total			2188.47

Hence the head resistance, 2188.47 square inches or 15.19 square feet.

Total area of supporting surfaces	420 square feet
Weight of machine, exclusive of engine and accessories	345 pounds
Weight of engine, propeller and countershaft, etc	210 pounds
Weight of radiator	15 pounds
Weight of water	30 pounds
Weight of gasolene, oil and tank, full	110 pounds
Weight of man, say	150 pounds
Total	860 pounds

As $\frac{860}{420} = 2.04$, the ratio equals 2.04 pounds per square foot; that is, flying weight equals 2.04 pounds per square foot.

SURFACE AND WEIGHT PROPORTIONS OF THE "SILVER DART."

While this aëroplane was in course of construction, tests and experiments were proceeding with the "June Bug." Circles were being made, and by the end of August, complete return flights were conducted with ease. After many trials J. A. D. McCurdy not only brought the machine back to her starting point, but described the figure 8 and landed within, perhaps, 150 yards from the starting point after encircling it. The following day I started from the other side of the race track, made a complete circle almost within the radius of the track (½ mile) and then continued the flight down the valley for ¾ of a mile and turned a second time.

"JUNE BUG" CHANGED AND RENAMED "THE LOON"

Shortly after these flights it was decided to experiment farther with the "June Bug," by removing her running gear, and attaching pontoon floats, with hydroplanes, in its place in an effort to rise from Lake Keuka.

It was during October, 1908 (on the 23d), that these plans were carried out. It was necessary to build two small floats to support the total weight of the machine and man, that is, 850 pounds.

The following dimensions were eventually decided upon: 20 feet over all, 18 inches beam, and 6 inches free board. The boats were constructed, skeleton like, of California redwood, and covered completely with rubber oilcloth. Completed they weighed 60 pounds each. They were spread 7 feet apart, catamaran-like, and connected by fish-shaped trussing to the lateral chords and central panel of the "June Bug." The vertical rudder, similar to that used in the "June Bug," was mounted directly at the stern of the catamaran, while the single-surface, front control was mounted directly from the bow, thus doing away with the usual cantilever trussing employed in the former machines. This gave a great saving in head resistance, and when finished looked very compact and neat.

The engine used was that designed for the "Silver Dart," which drove direct and used an 8-foot propeller of 6¼ feet pitch. The machine thus constructed was renamed "The Loon."

On Saturday evening, November 28, 1908, the first experiment was tried. "The Loon" had been wheeled around to the starting point, consisting of two parallel wharves. The engine was started, the seat was taken by Mr. McCurdy, and the machine started on her maiden swim or flight. The exact push of the propeller at the time was not known, although it was probably in the neighborhood of 250 pounds. Hardly had the machine covered 400 yards when the propeller shaft was twisted off. This concluded the experiments for the day. The speed obtained was calculated to be 20 miles per hour. A new propeller shaft was soon constructed out of the solid instead of the steel tubing formerly used, and on the afternoon of November 29 the second trial was made. The wind was blowing directly down the lake with a velocity of five or six miles an hour. The auxiliary ports in the engine, which were closed in former trials, were now opened, and it was anticipated that the speed of the engine would be greatly increased. As before, Mr. McCurdy operated. Agreement had been made to first run down the lake and

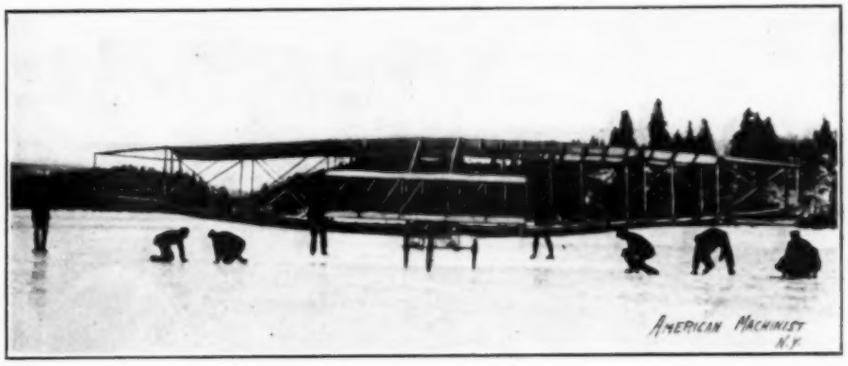


FIG. 11. A START OF THE "SILVER DART"

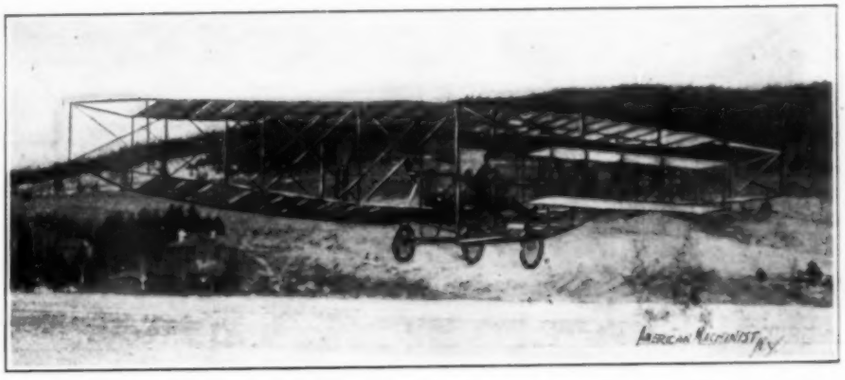


FIG. 12. THE "SILVER DART" IN FLIGHT

back again against the wind, to ascertain whether there was any difference in lift due to the wind. It seemed that after running about 100 yards "The Loon" obtained her maximum lift. By "shooting" her, that is, by suddenly elevating the bow control, the bows would entirely lift out of the water without the depression at the stern which would result in the case of an ordinary motor boat. A course of a mile was held down the lake, turning and coming back against the wind, thus covering a distance of two miles in four minutes and 26 seconds. This gives a speed of over 27 miles an hour.

It was calculated by the late Lieutenant Selfridge that the speed required to lift the "June Bug" off the ground was about 23 miles per hour, and although the weight of "The Loon" was very little more than the "June Bug," still an increase of speed of four miles over 23 was insufficient to cause her to take the air.

The motor was then transferred from "The Loon" to the "Silver Dart" and a few tests made. However, but little flying was done in Hammondsport with the "Silver Dart." The longest flight was 1½ miles.

Flights of the "Silver Dart"

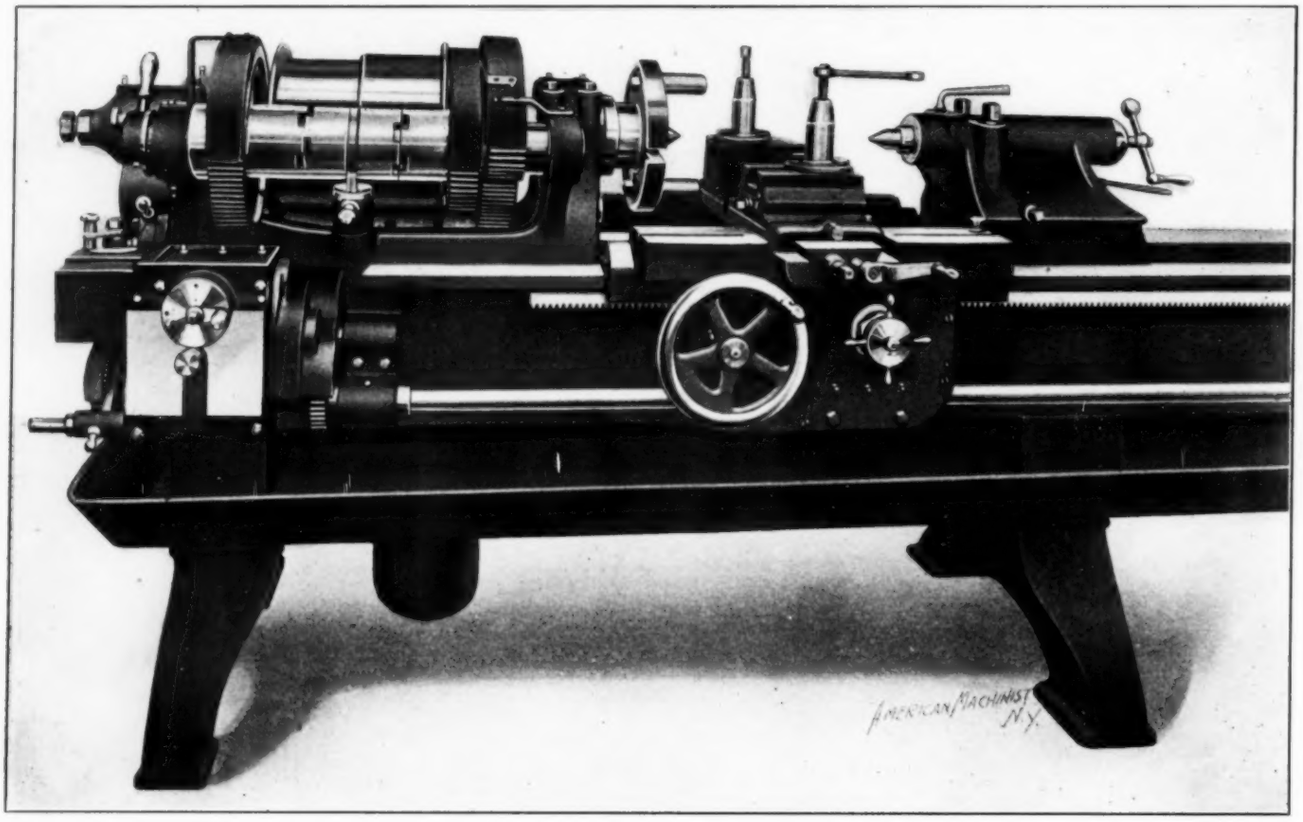
The beginning of the new year, 1909, saw this machine packed and shipped to Baddeck, Nova Scotia, to be tested further over the ice. She was soon followed by Mr. McCurdy and myself. Experiments were also to be conducted with Doctor Bell's tetrahedral aërodrome No. 5 after the "Silver Dart" had done her duty. Much was expected of this machine and she has not failed to show her quality. The first flight ever made in Canada by a flying machine proved to be that of the "Silver Dart" of ½ mile. On the same afternoon, during February, Mr. McCurdy successfully flew his machine 4½ miles. During the same week longer flights were made of 9, 15 and 19 miles; elevation about 40 feet. The last, 19 miles, has been her longest to date, but by no means is she restricted from going any distance. On this occasion she was brought down owing to the severe cold suffered by the aviator. Fig. 11 shows a start of the "Silver Dart" on the ice at Baddeck, and Fig 12 the machine in full flight.

The object of the Aërial Experiment Association at the time of its organization was to fly a successful flying machine and get into the air. This object has been more than accomplished. A successful flying machine has been built according to the plans of each member of the association, and all, with the exception of Mr. Bell, have made flights. The association, therefore, came to a close March 31, 1909.

A 20-inch Roughing Lathe

As an indication of a rigid adherence to a belief in simplicity in machine-tool design and construction, in the face of the recent tendency to geared heads and a multiplicity of feeds, the lathe shown herewith and built by Schumacher & Boye, Cincinnati, Ohio, is especially interesting.

Although this is nominally a 20-inch lathe and has all the strength necessary for such a machine under the heaviest cuts, it is designed especially for roughing shafts up to 5 inches in diameter only and on this class of work it is producing some remarkable results. A single instance, the reduction of the end of a 4-inch shaft to 1⅝ inches at one cut, will give some idea of its rigidity and power.



A 20-INCH ROUGHING LATHE

No lead screw is provided as none is needed on this work, or for that matter on 90 per cent. of ordinary lathe work, but it has a very substantial feed box giving six changes from 1/32 to ¼ inch per revolution of the spindle.

The drive is a two-step cone having steps 13 and 11½ inches in diameter, for a 6-inch double belt, and with the double back gear gives six changes of speed, the first back gear being 3 to 1 and the second 6 to 1. Both back gears are readily operated from the front of the lathe, and the feeds are also very convenient.

The spindle is 4⅜ inches in diameter, with a front bearing 8 inches long, and is bored out to form an oil chamber from which the bearings are lubricated by centrifugal force. The end thrust of such a lathe spindle is a difficult proposition, but it has been successfully met in this case by hardened and ground steel washers 2 inches in diameter with a small hole in the center and having grooves in the face, which insures thorough lubrication.

The apron is of the double-plate type and designed to meet the strains imposed by this class of work. Double tool blocks are provided and all slides are of steel castings. The tailstock is also special, and careful attention has been paid to clamping it. As will be noticed, the tailstock nose is extended so that the spindle is stiffly supported. All gearing is of steel and carefully guarded.

The countershaft has two speeds and is self-contained, being mounted on a substantial base which insures alinement and has many good points. Friction pulleys of the self-oiling type carry 7-inch double belts and run 340 and 365 revolutions per minute. As can be seen, the lathe is mounted on a pan and is provided with an oil pump and flexible tubing for thorough lubrication of the work. It is a plain, heavy lathe, designed on simple lines for a special purpose and is guaranteed to run to the cutting limit of any tool steel.

Keeping Knowledge In—or Out

By R. E. Marks

This may sound like a fairy tale—but it isn't. It's more like a tragedy to those who bought stock at 240 and would be glad to sell at 70—with no buyers—and it happened in this wise.

The Crosscut Saw Company, which of course, isn't its name, started business in the good old days and had built up quite a large business. That was when margins were large, when you sold goods by going to a hotel and notifying your customers that you were in town and would condescend to see them on Friday at 2:30 if pleasant, or not otherwise engaged. And they came.

But with the new regime of seeing customers at their office, of hustling for orders and cutting the cost of manufacture, the Crosscut people had several severe, sudden jolts and awoke to find that they had their choice between maintaining the good, old fashioned conservatism and probably going broke or succumbing to the undignified modern plan of hustling for business.

That's how they came to get my friend Billy Jackson to run the plant. Billy was a hustler and he had several large chunks of misgivings when he first tackled the job. Everything was under lock and key. Billy's office was a sanctum that it took three keys and seven passwords to get into. His assistant superintendent had been brought up in the shop and had the same disease, so Billy gave him a vacation in this wise.

"Mr. Jones, you need a change. You've been shut up pretty close for several years and besides I want you to see some of my friends in Hartford, Albany, Rochester and Buffalo and see how they run their shops. Perhaps we can get some new ideas."

"But they are our competitors, they won't let me in," protested Jones.

"Oh! yes they will. They'd let you in anyhow, but if you mention my name they'd show you anything they've got, and you'll find some mighty nice machinery too."

So Jones started on a three-weeks trip, with fear and trembling to be sure, but hoping that he might get a little rest at least. While he was gone Billy took off a bushel or two of locks, gave orders that anyone who asked to see him be attended to at once and without any handcuffs or guarantee of good behavior. Then he started to try and modernize the old shop which, as is often the case, was about as cheerful as an attempt to revive a corpse.

And then Jones came back.

Only stayed away ten days but he was an entirely different man when he came back.

"Didn't expect you back so soon Mr. Jones. Did you see them all, or did you have some trouble getting into the shops?"

"Bless you no, not a bit of trouble. Say! Mr. Jackson, do you know *everybody* in *all* the shops in this country? I didn't find a shop where the name of Billy Jackson wouldn't have pried open the safe. I'd a got in anyhow, because they didn't ask any special questions and seemed glad to show me.

"I asked one of them how he dared to let strangers in on account of their stealing a lot of ideas, and I've been thinking of his reply ever since. He said he could get as much out of the average mechanic as the vistor did out of him, and that he got a lot of good ideas every year. That's the reason I came home. I've seen more good things than I can put into practice in a year. I've also found out why you sent me out—to find out the advantages of an open shop instead of the close-communion affair we've been having.

"Mr. Jackson, we thought we were keeping all our knowledge to ourselves, but we were keeping more knowledge *out* than we did *in*. I can see now where I've missed lots of information by not seeing traveling men. I thought you were crazy when you wanted to open up the shop, but you knew the game better than I did and I'm with you."

So the shop was opened to visitors; new tools put in, and new methods adopted, and all went merry as a good shop ought to. Earnings increased so that a dividend of 12 per cent. was paid regularly, besides laying aside a sinking fund (which ought to be called a non-sinking fund because it helps to prevent you sinking in time of trouble) of such generous dividends that the stock went a kiting.

Then Billy wanted to do something for some of the men who had helped him make the thing a success and the powers that be kicked over the traces. If they wanted any more than their regular pay, they could buy a share or so of stock and get the dividends. Billy might be a good shop man but he was dead crazy when it came to high finance. So he bade them a fond adieu, sold them what little stock he had accumulated at the market price of 240 and sought other fields of endeavor where it wasn't so easy to make things better.

A safe, sane and highly respectable super, who was properly soft-pedaled to prevent discord and insure a low, sweet, harmonious rythm, was secured to run the Crosscut Saw Company as of yore. Now that they had caught up with the procession, there was no need of snooping visitors, and the locks, the passwords and the gum-shoe atmosphere of the office were restored in all their pristine beauty.

But the rest of the saw makers were inconsiderate enough to keep right on improving their way and their products and also of reducing prices to match. They didn't know enough to let well enough alone, some people are built that way, and as a result, which might have been ferreted out by a Sherlock Holmes from an early statement in this narrative, the others had them skinned before they knew their epidermis was in danger of removal, so that the sinking fund has been properly and effectively sunk, the dividends linger, only as sad memories of the past, and the holders of stock would take 70, rather than disappoint a rising young man who wanted to become a useful member of society.

By an enactment of December last a law comes into force this month in Austria containing a section somewhat similar to Section 27 of the British Patents Act of 1907, by which patents in Austria will be revocable at the expiration of three years from the date of publication, without any notice, if the patentee neglects to work the patent in Austria to an adequate extent.

Transfusion of particles of different kinds of metals through the agency of electrical current has been held by some to take place just the same as in the case of electrolytes upon which action electroplating depends. To prove or disprove this contention an experiment on a product composed of aluminum and copper, firmly welded, through which an electrical current was passed continually for one year. After the two parts were separated it was found that neither metal contained any particles or traces of each other.

The Phoenix Iron Works of Hartford

The Shop Where the First Lincoln Milling Machine, Index Millers, Gear Cutters and Many Other Noted Machine Tools Were Built

BY E. A. DIXIE

Among the famous old-time New England machine-tool builders none enjoyed a higher reputation than the Phœnix Iron Works, of Hartford, Conn. This shop was started by Levi Lincoln in 1834. Lincoln was an inventor of considerable ability, among his inventions being the hook and eye, and by the way, nearly all, if not quite all of these modern variations of the hook and eye with humps and bumps and bends to keep them from coming apart, were invented by him generations ago and forgotten, but many of the old samples he made can still be seen if one knows the right one to apply to in Hartford.

The business was carried on for many years by George S. Lincoln, under the style of George S. Lincoln & Co., and during that time machine tools of every description were turned out in large quantities. The firm was progressive and advertising matter was gotten out freely, illustrated with copper-plate engravings and lithographs.

Through the courtesy of Mr. Taylor, of the Taylor & Fenn Company, who are the successors to the old Phœnix Iron Works, I am able to give reproductions of these old illustrations of punch presses, planers, lathes, gear cutters, single- and multiple-drill presses, index millers and the famous Lincoln milling machine, of which type probably more are used today, throughout the world, than any other. In passing I may mention that Mr. Taylor is a great-nephew of George S. Lincoln, and a great-grandson of Levi Lincoln, founder of the works.

Besides turning out machines of high reputation, some of the foremost machine-tool builders of the United States came from the Phœnix Iron Works. Francis A. Pratt was foreman there and Amos Whitney was contractor.

The existence of the Lincoln milling machine is, in common with many other machines, due to the demand for interchangeable small arms and it is not out of place to mention here that Samuel Colt, inventor of the Colt revolver, is reputed to be the first to make revolvers with duplicate parts, and it was in the old frame building, across the street from the Taylor & Fenn works, now used principally for storage, that he worked on the first Colt revolver.

Robbins and Lawrence, two expert mechanics, came from Windsor, Vt., to Hartford, to make Sharp's rifles. They brought with them, I am told, the idea of using a formed cutter carried on an arbor in a lathe with which they could machine parts, secured to suitable fixtures fastened on the slide rest, so that they would be duplicates.

This idea resulted in the designing of the Lincoln milling machine by Francis A. Pratt. If we compare the illustration of the Lincoln milling machine, shown in Fig. 2, with a simple engine lathe there are many points of similarity. The principal point of dissimilarity is the vertical adjustment for the spindle in relation to the work, but which was obviously easier to accomplish in this way than by making the spindle hight fixed and adjusting the work table, besides being more rigid.

Fig. 2 is reproduced from a lithograph. The exact date of the making of the first Lincoln milling machine I was unable to obtain but it was made early in the fifties for I find in one of the old account books the following item: "March 27, 1855. Sold to Robbins and Lawrence 12 m. m. without back head @ $225 each. 1 fan blower $60." And again:

"May 12, 1856 Brown, Dimock & Co., Quincy, Ill. 1 milling machine without back head $275." The price had gone up $50 in the interim. Comparing the cut shown with the modern Lincoln milling machine one is inclined to think either that Pratt designed a machine which would not admit of much improvement or that very little has been done by modern designers to improve upon his design. The building of the Lincoln milling machines was in the hands of Amos Whitney as contractor.

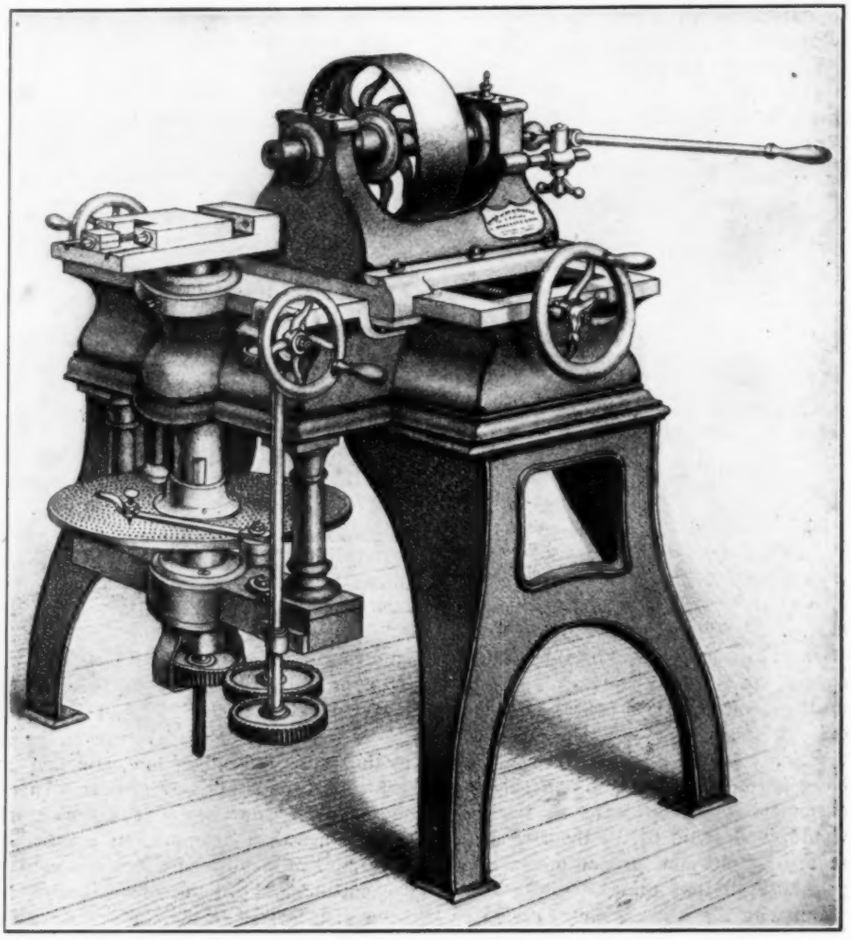


FIG. 1. INDEX MILLING MACHINE

Fig. 1 shows an index milling machine which also owed its origin to the demand for interchangeable gun work. This machine was also designed by Pratt and the first one built by Whitney, who turned out, for a time, four of these machines a

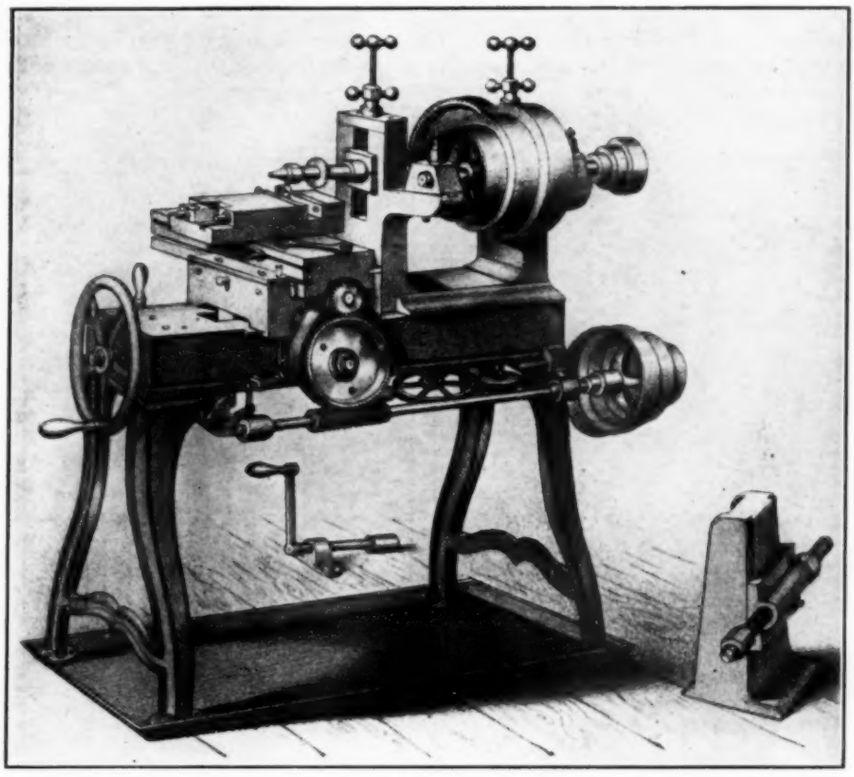


FIG. 2. THE ORIGINAL LINCOLN MILLING MACHINE

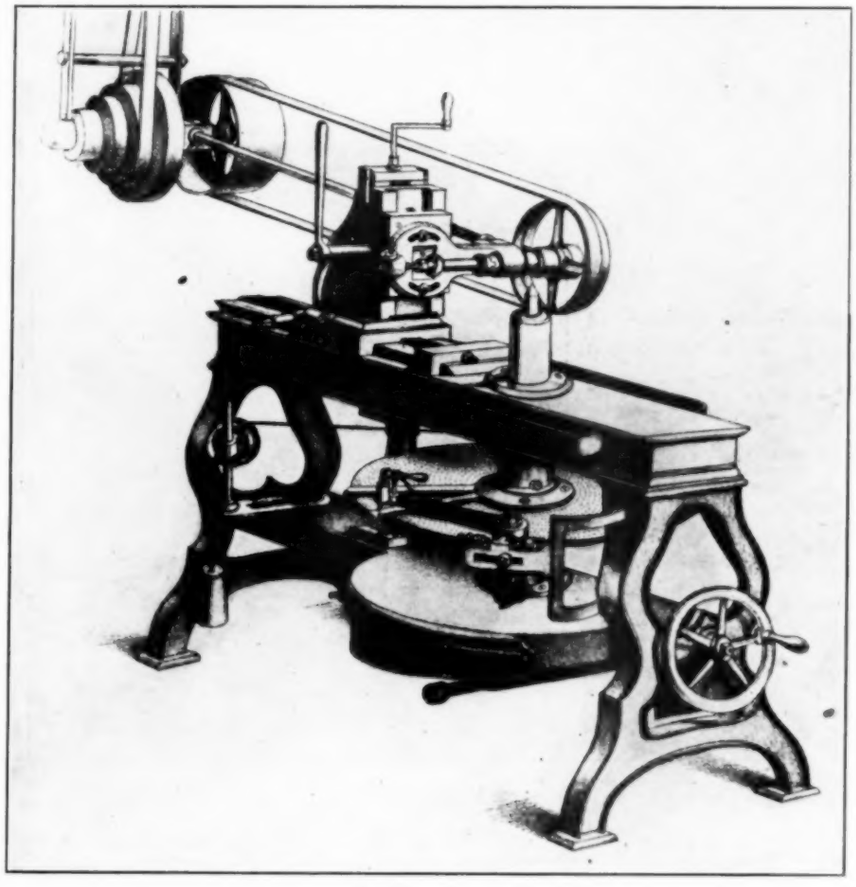


FIG. 3. THE OLD GEAR CUTTER

month for Colt's armory. The first order of Colt's which I could find was a decent-sized one:

"May 1861 Saml. Colt,
100 m. m. @ $235 each
10 Ind. m. m. $430 each
10 4 sp. drills, $225 each
4 (large) 4 sp. drills $240 each."

Amounting in all to over $31,000, quite a large order for those days.

I have run one of these old index milling machines myself and on certain classes of work it was not unhandy. Fig. 3 shows a gear cutter also designed by Pratt, and built by Whitney. With this machine spur and

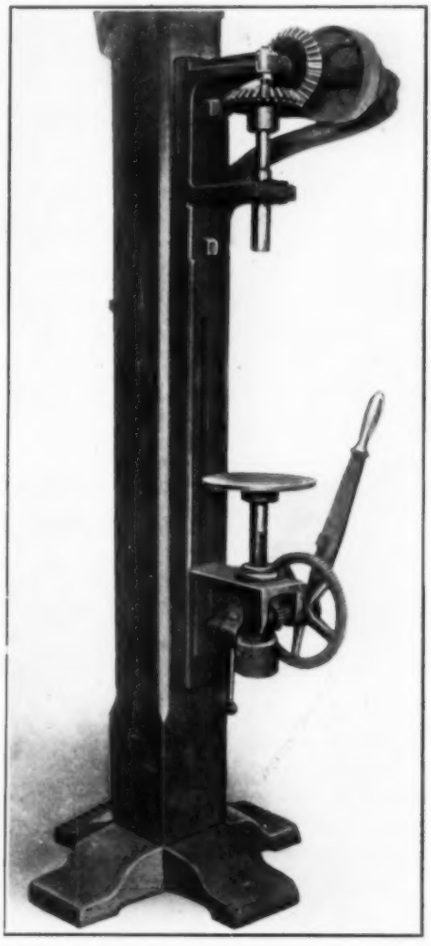


FIG. 4. SENSITIVE DRILL PRESS

bevel gears up to about 5 feet diameter could be cut. Mr. Whitney made the master plates for dividing the index plates of the machines shown in Figs. 1 and 3. These were done by a method which is fairly well known, a strip of metal being drilled with the required number of holes plus one and a disk turned so that the strip would fit around it and the two end holes match up.

Fig. 4 shows a sensitive (?) post drill. There is no record of how old it is nor who built it. The spindle has no travel, is journaled in the lower bearing on the bracket and has a female center on the

upper end in which a male center, provided with adjusting nuts, fits.

The bracket carrying the table is adjustable vertically on the bed which is secured to a post. The cylindrical central shank on the table has teeth cut on it as shown. These engage with a pinion on a shaft to the other end of which is secured a ratchet wheel. Loosely mounted on the same shaft is a lever on which a pawl is hung which engages the teeth of the ratchet wheel. This forms the feed mechanism. The age of this sensitive drill is unknown. An old man who has been 62 years with the Phœnix Iron Works told me it looked as old when he came to the shop as it does today.

Fig. 5 shows an upright drill designed by Pratt previous to 1862 and equipped with automatic feed. The rack-and-pinion method of elevating the table is used on this machine. Besides the lithograph from which Fig. 5 is reproduced I have a photograph of one of these drill presses which is in use today.

FIG. 5

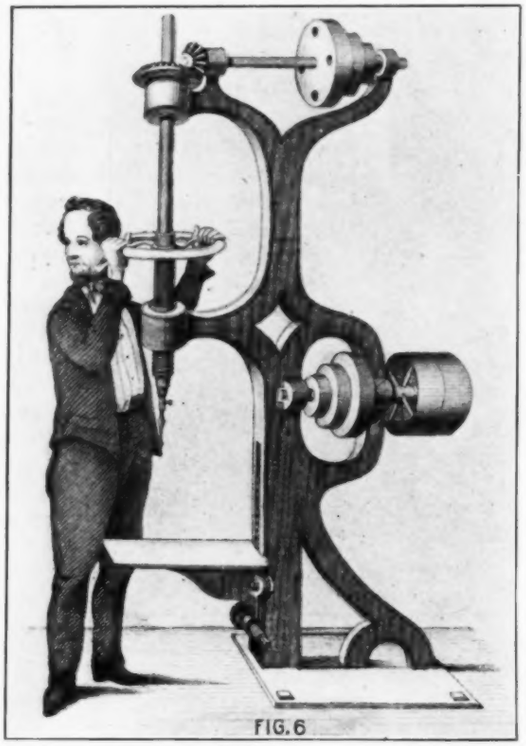


FIG. 6

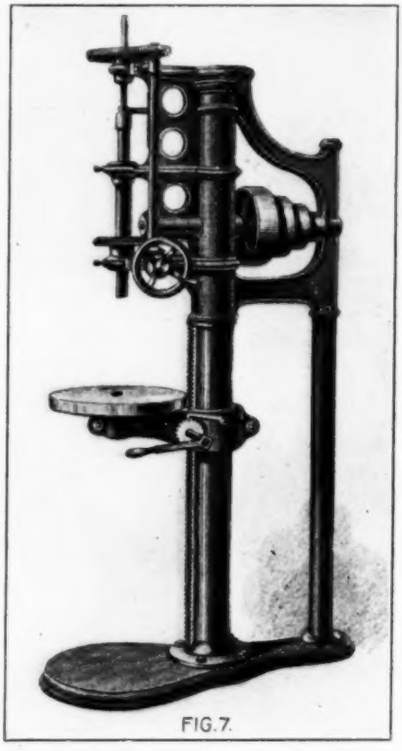


FIG. 7

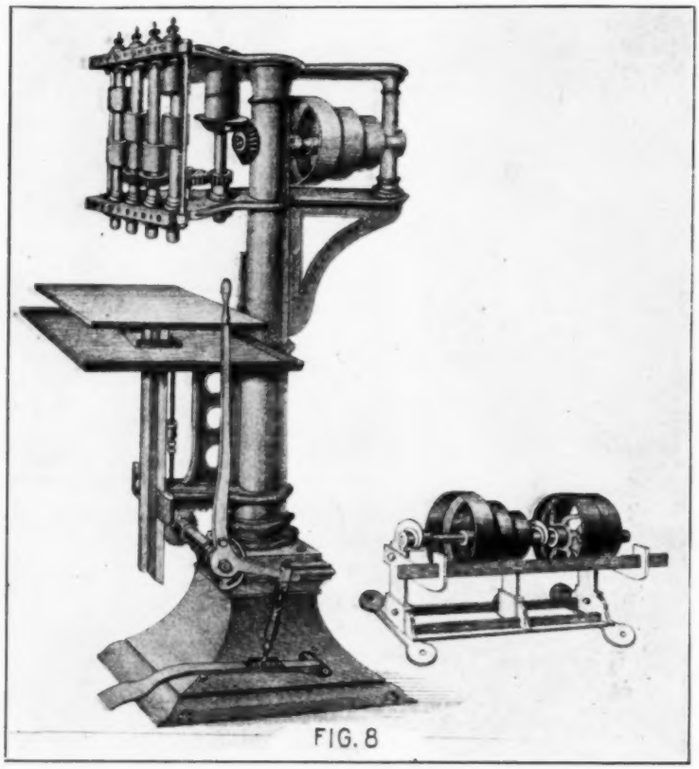


FIG. 8

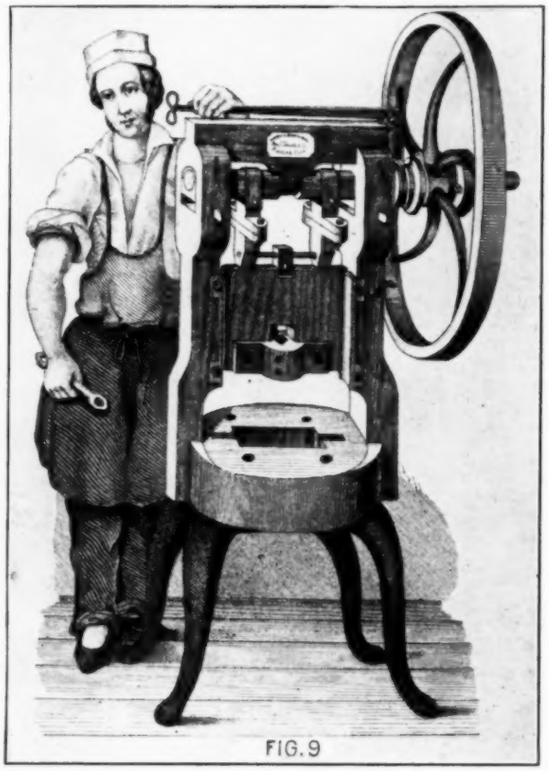


FIG. 9

OLD DRILL PRESSES AND AN ANCIENT PUNCH PRESS

Fig. 6 shows a very old drill press built previous to 1845. I have reproduced the lithograph for this article but have a photograph of one of these machines which is still in commission. The ex-

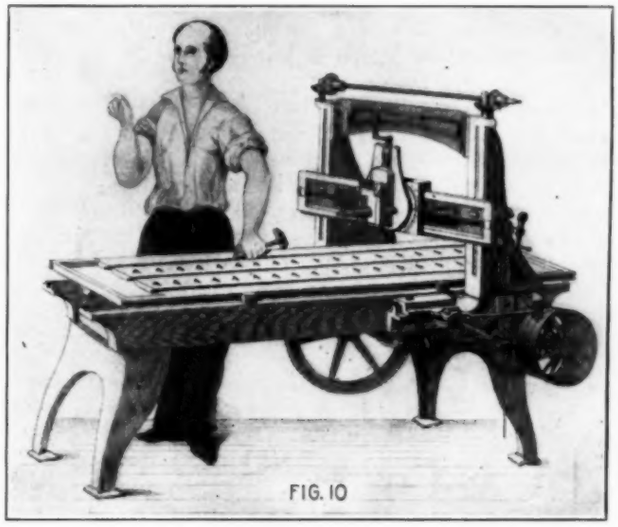


FIG. 10

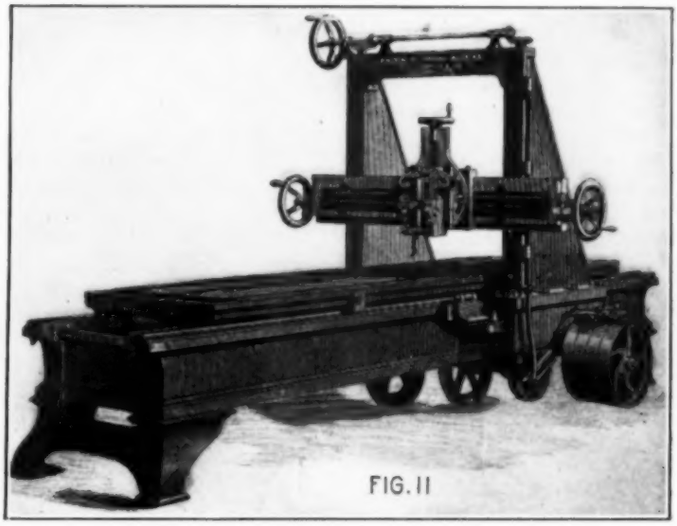


FIG. 11

TWO OLD TIME PLANERS

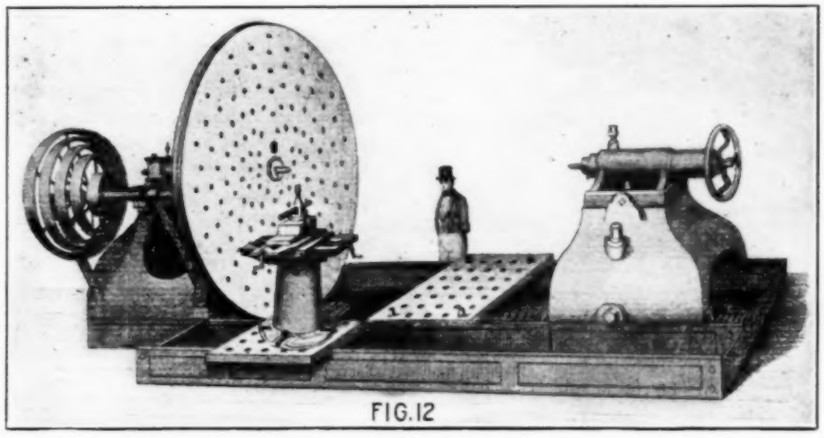


FIG. 12

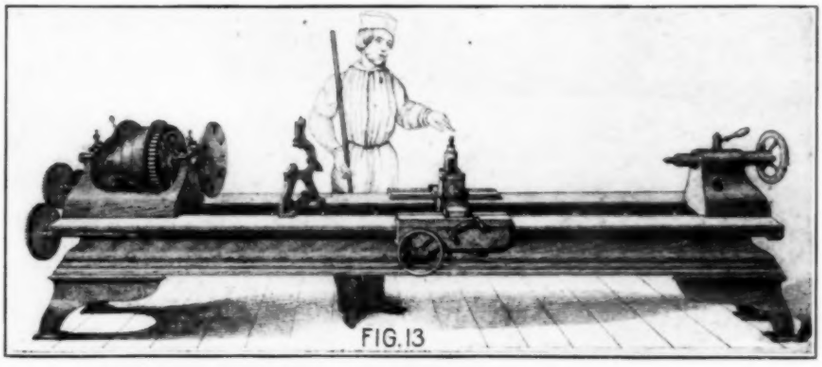


FIG. 13

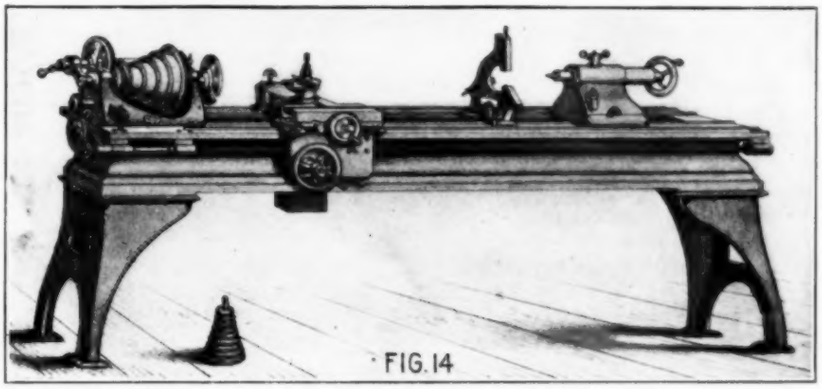


FIG. 14

THREE OLD LATHES

pectant look on the face of the operator reminds me of the signs one sees in the wheel houses of transatlantic steamers: "Passengers must not speak to the man at the wheel." The operator looks as if he were just about to be ordered to "port his helm."

In this machine the rack-and-pinion elevating device is used for the table, but there is no ratchet and pawl to prevent it dropping, while the table is being clamped by the bolts at either side for this purpose.

Fig. 7 shows a 16-inch drill press designed and built by Pratt & Whitney about 1864 and, I am told, copied by the Phœnix Iron Works.

Fig. 8 shows a multiple-spindle drill press built about 1855. In this machine the two middle spindles were gear-driven and evidently intended for heavier drilling, while the two outer spindles were belt-driven. The table was elevated either by hand or by foot lever and rack-and-pinion. Stops were provided, as shown, for limiting the travel of the table up and down.

Fig. 9 shows a reproduction from a copper-plate engraving of a punch press which was built about 1850, or perhaps earlier, and designed, I am told, by a man named Jilson. It will be noted that the clutch is thrown in and out of engagement by hand. The unhappy look on the operator's face would lead one to believe that he has just ruined a die and was waiting to hear what the foreman would say. The design is not at all dissimilar to that of the more modern "Stiles" press.

Fig. 10 shows a rack-driven single-belt planer built previous to 1854. It will be noted that the two elevating screws for the cross-rails are the same hand, apparently left-hand. As in many of the early planers, the table was made very light. The V's are apparently nearly rectangular and have a comparatively broad, flat bearing on the bottom. The belt-

shifting gear is of an old pattern, the dogs on the table striking a sliding piece which has a cam formed on the outer edge which actuates the shifter lever. Automatic cross-feed, but no vertical feed, is provided.

Fig. 11 shows a more modern planer of the double-belt type built probably about 1864. The contractor who took charge of the building of planers in the Phœnix Iron Works was I. P. Davis. This tool embodies several more modern features. Right- and left-hand elevating screws are used but whether that is better than having both screws of the same hand or not is open to discussion. Vertical feed by splined shaft is used and a reciprocating rack for transmitting the feed. Two belts also take the place of one in the older style. The V's are of comparatively large size and the table apparently heavier. The housings come nearer to being what I consider the correct shape than housings I have seen on planers built long after this one was. Excepting, perhaps, the Lincoln milling machine no line of machine tools brought more fame to the Phœnix Iron Works than its line of lathes. These were designed by a man named Rogers.

Fig. 12 shows a large lathe for turning locomotive driving wheels, which was built about 1850 for the Providence & Fishkill railroad.

One of these lathes was sold as follows: "Feb. 28, 1853 New Haven Mfg. Co., 7 ft. lathe $1000." The bed of this lathe so says the lithograph, was 15 feet 3 inches long. It would turn 7 feet 3 inches between centers and swing 7 feet 3 inches. Altogether this lathe is a rather cumbersome affair. There is no sign of an automatic feed for the slide rest, but in all probability an automatic ratchet feed of some sort was available. The cone pulley was a primitive affair as were also the bolted-on brackets which supported it. The spindle was of cast iron which was common practice for spindles of large lathes in those days.

The tailstock is comparatively modern in design with its set-over device, rack and pinion for moving it on the ways and pawls engaging with the racks on the bed to prevent slip.

The gentleman at the rear is presumably a railroad purchasing agent. His expression plainly indicates that his road needs that lathe. He evidently regrets it but with an air of resignation he dives down into his hip pocket for his roll, all of which is plainly shown in the illustration.

Fig. 13 shows an engine lathe designed by Rogers and built previous to 1854. These lathes were built in three sizes, 20, 30 and 40 inches swing, with beds 10, 14 and 16½ feet long, respectively. The prices obtained for lathes by the firm are of interest: 12-inch lathe, $175; 17-inch lathe, $225; 24-inch lathe, $455; 20-inch lathe, 13-foot bed, $355; No. 1 lathe, $315; No. 2, $540; No. 3, $900; 7-foot driving-wheel lathe, $1000.

On the lithograph of Fig. 13 the title reads, "Screw Cutting Engine with Patent Rest, with improved cast-iron bed, cast-steel spindle, feed motion carried by a screw, with a toothed rack for moving tool rest by hand, gib'd rest, with stationary and traveling back rest, back geared and change gears for cutting screws. Overhead pullies, &c., complete."

The bed is flat on the top, and judging by the braces showing between the two sides of it, was a very substantial one for that time. The weary-looking individual with the square paper cap who poses at

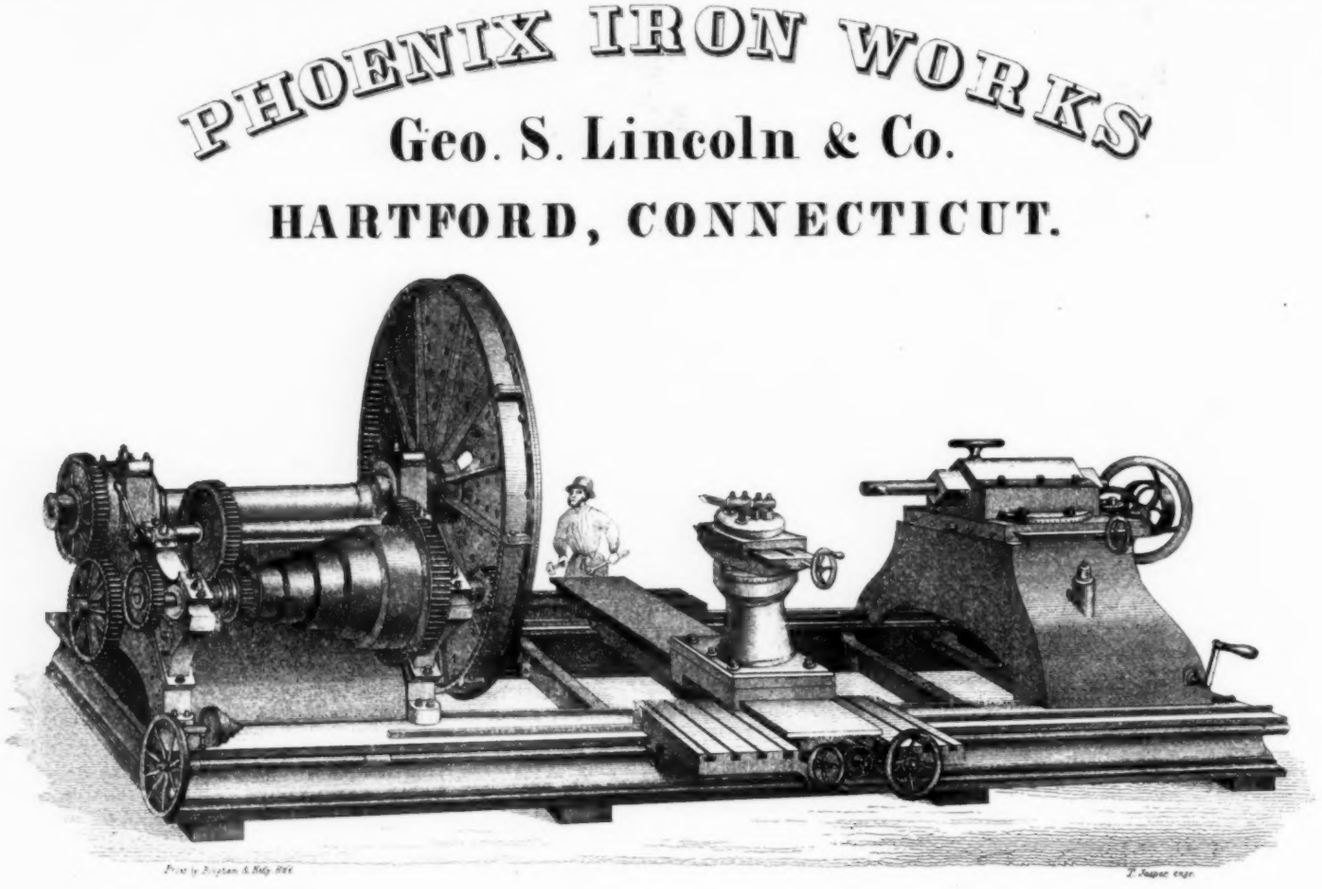

PHOENIX IRON WORKS
Geo. S. Lincoln & Co.
HARTFORD, CONNECTICUT.
Engine Lathe.
Adapted to all kinds of heavy work Bed 18 ft long Turn 10 ft 6 in. Swing 7 ft 2 in. Weight

FIG. 15. THE BIG LATHE

the back of the lathe has evidently been asked to tighten the tool-post set screw with the barge pole, there being no left-hand monkey wrench available.

Fig. 14 shows a lathe of more modern design, and was built by Amos Whitney about 1856. In this lathe we see the weighted rise and fall rest and tumbler gears for reversing the direction of the feed. The binding device for the tail-spindle is of the well known eye-bolt type, now obsolete. This lathe would turn 6 feet long by 16-inch swing. There is still one of these lathes in the shops of the Pope Manufacturing Company, Hartford, Conn., numbered 294, and I was told by the man who ran it that it is still capable of good work.

Figs. 15, 16 and 17 show a large lathe which is remarkable for its handiness, and which is a very desirable tool for a jobbing shop. This lathe was built about 1856 and turns 10 feet 6 inches by 7 feet 2 inches. Fig. 15 is reproduced from the original copper-plate engraving, while Figs. 16 and 17 are reproduced from photographs of one of these lathes still in commission and turning out good work in the shop where it was built. Fig. 17 shows the driving mechanism. The spindle is cast iron, of large dimensions and has a hole through it.

Figs. 15 and 16 show the tailstock, which has some features worthy of mention. The tailspindle is square. Instead of being actuated in and out by a screw and nut in the usual way one end of a connecting rod is pivoted to it and the other end of the connecting rod is pivoted to the face of a worm wheel. A large hand wheel and a pulley are mounted on a shaft which carries a worm which engages with this worm wheel so that the spindle can be actuated in or out either by hand, when tightening the center on work to be turned between centers, or a belt drive from overhead can be applied to the pulley and a more or less rapid reciprocating motion of the tailspindle be obtained for splining, broaching, or similar work. By referring to Fig. 16 it will be noted that there is considerable latitude to the set-over movement of the tail-spindle. The tailspindle is also capable of adjustment to an angle which permits taper boring, using a boring tool in the tailspindle or taper keyway cutting or splining may be done with a suitable tool placed in the tailspindle. The cross-traverse of the tool post is from side to side clear across the lathe, and not, as was common in those days, by short cuts of a few inches and then a shift of the tool post for a cut of a few more inches.

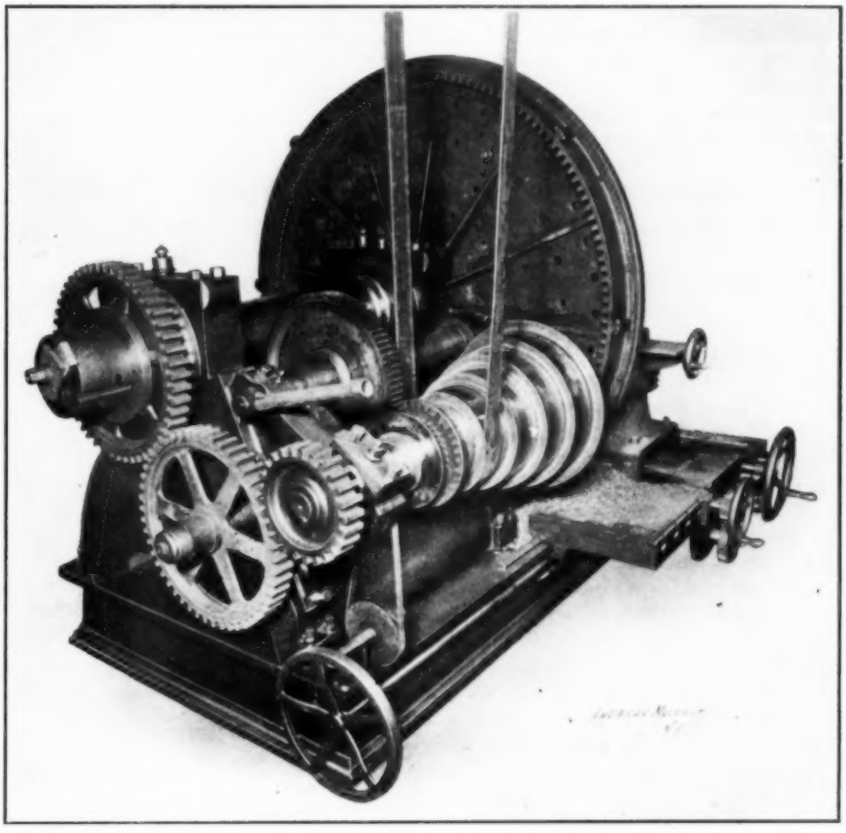


FIG. 17. LARGE LATHE SHOWING HEADSTOCK AND CARRIAGE ONLY

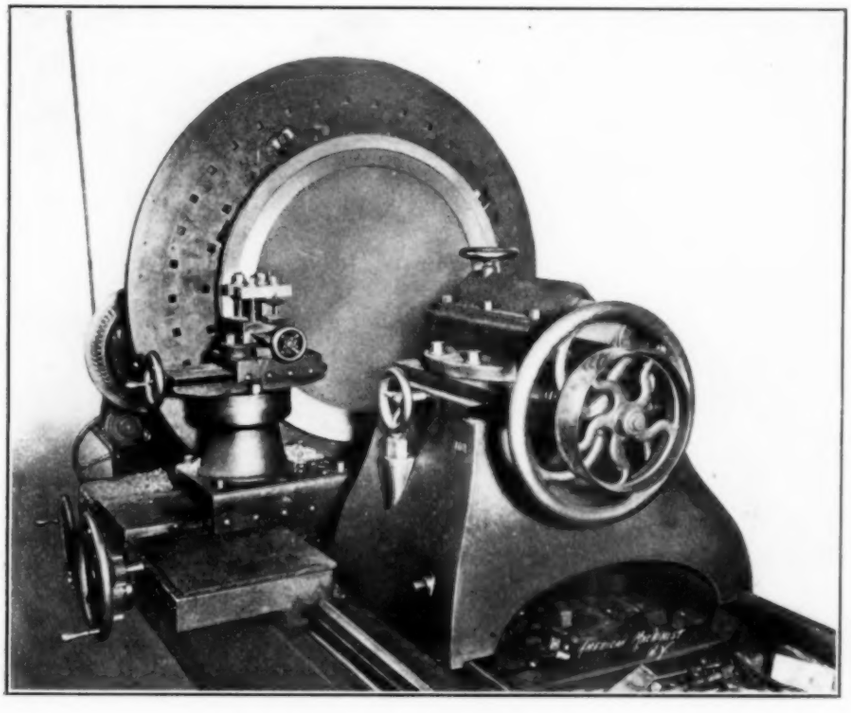


FIG. 16. LARGE LATHE FROM TAILSTOCK END

During the Civil war the Phœnix Iron Works was building machine tools to be used directly and indirectly by the Government. The importance of this work is attested to by the fact that when the zealous recruiting agents drafted men from the Phœnix Iron Works, the Government interfered and the men were promptly sent back to work. The prosperity of the Phœnix Iron Works was, it is said, due, in a general manner, to the contracts it had with the Government. These were signed before the war and called for payment in gold. After the war broke out gold rose to a premium of 250 and the firm profited in proportion. The men were, of course, paid with greenbacks.

When Pratt & Whitney left the works and started on their own account, instead of showing ill feeling at the loss of two such valuable men, Mr. Lincoln was not only on friendly terms with them, but

gave them an order for some $30,000 worth of tools.

After the death of Mr. Lincoln the shop had, for some years, a rather precarious existence, but several years ago the works was taken over by the Taylor & Fenn Company, and under them is regaining its old-time prestige.

Gear Grinding Machine

The Ward gear-grinding machine, illustrated in the accompanying halftones, is designed to grind gear teeth to within 0.001 inch of correct size, and is intended for operating not only on hardened gears, but for finishing gears in general after roughing out on the gear cutter, thus doing away with the second or finishing cut commonly taken on the gear cutter. It is also adapted to grinding gears from rough-toothed castings of any material, as cast iron, cast steel, etc. The machine shown is designed to handle gears up to and including 12 inches in diameter, with teeth up to 4 pitch and width of face up to 4 inches. More than one gear may be ground at a time if the total face width does not exceed that mentioned, or four inches.

As shown in Figs. 1 and 2, the gear, rough-cut or cast, as the case may be, is mounted on an arbor for finishing in the

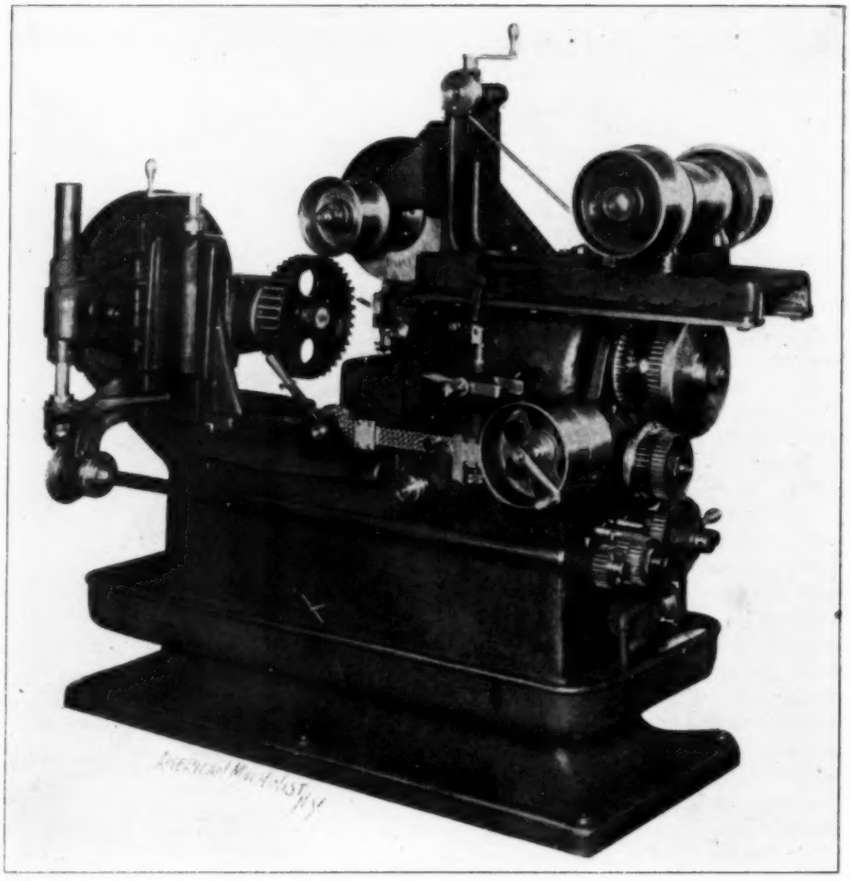


FIG. 2. GEAR-GRINDING MACHINE

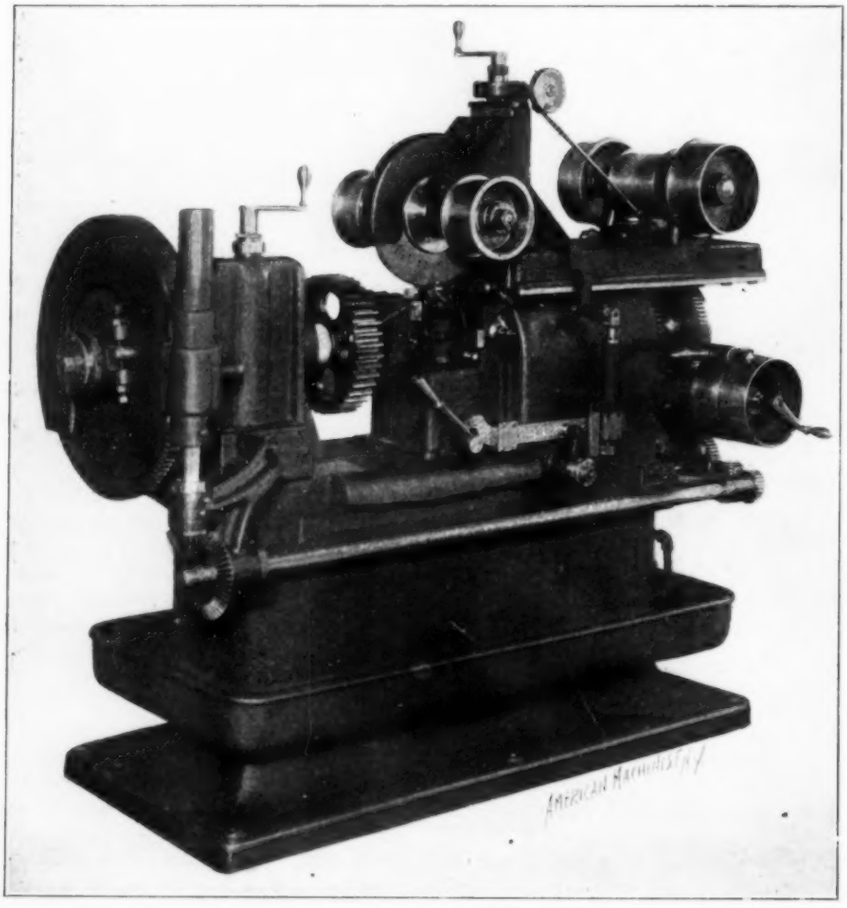


FIG. 1. GEAR-GRINDING MACHINE

grinder. The work is held in a manner similar to that employed in gear cutting. The indexing worm wheel is amply large to insure precision. The taper hole in the end of the spindle is adapted to receive collets for holding work of special design. A secondary indexing wheel permits the adjustment of the work to any

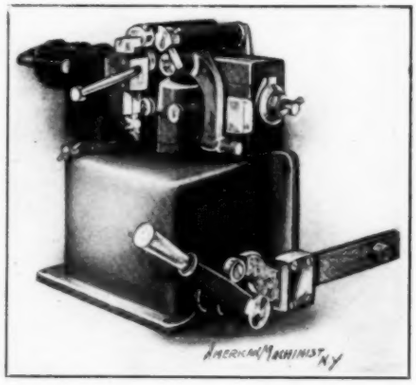


FIG. 3. FORMING DEVICE FOR GEAR-GRINDING MACHINE

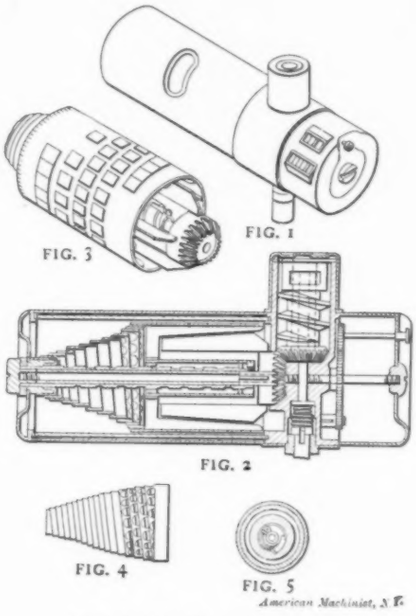
required position on its axis, thus enabling the operator to omit such teeth as do not require grinding on the roughing-out operation. The index head is adjustable longitudinally to permit of bringing the work within the range of travel, of the grinding wheel. The arrangement of the change gears, by means of which the in-

dex wheel is operated, is clearly shown in Fig. 2.

The grinding wheel which is 12 inches in diameter is carried on a hardened and ground spindle running in bronze boxes and may be removed easily without disturbing or exposing the bearings. The wheel head is carried by a sliding ram by which the wheel is passed across the work. The head is adjustably mounted at the front of the sliding ram or carriage. An indicator shows the progress of the grinding at any time and also indicates the completion of the work to the required size. An interesting feature is the forming device, by means of which the wheel is automatically kept to the required form. With this device any standard form of spur-gear tooth and many so-called freak forms may be developed, if required, on the sides of the wheel and reproduced in the gear. This forming device is seen in Fig. 3. The two rocker arms pivoted at the top, whose movements are controlled by former plates, carry a pair of diamonds for operating upon the sides of the wheel. This forming device is automatically operated at each movement of the wheel slide if so desired, or it may be thrown out of operation when not required.

In connection with the indexing device a mechanism has been developed by which the index driving and driven parts are automatically locked together and so held during the indexing period, being released at the end of the indexing operation and the driven parts then locked in position in the usual manner after having made one complete revolution.

It is the intention that water shall be liberally used and a circulating pump and large reservoir have, therefore, been provided. The pump is located at the end of the machine, as shown in Fig. 2. The method of driving the wheel and the gear train will be obvious upon inspection of the illustrations, and no explanation is, therefore, required. The machine is built by the Gear Grinding Machine Company, Detroit, Mich.



THE CASGRAIN SPEEDOMETER

The Casgrain Speedometer and Its Calibration

A new automobile speedometer is illustrated by the line engravings, Figs. 1 to 5, inclusive. A speed indicator is about to be brought out on the same principle, the use of a varying force transmitted by a body of liquid set in motion by the vanes of a revolving paddle wheel.

The method of calibrating the instrument is of interest, as well as its mechanical construction.

The indicating cylinder, carrying the numbers representing miles is under the control of a spiral spring of flat section, as shown by Fig. 4. On the inside of this cylinder is a series of small vanes. Within the cylinder is confined a small amount of liquid, preferably a petroleum distillate. This liquid is set in motion by a paddle wheel driven by power from the automobile wheel or other mechanism that is to be tested. This moving liquid exerts a force or drag on the vanes of the indicating cylinder. Thus this cylinder is rotated against the resistance of the spiral compensating spring and the numbers on the cylinder brought into view through the casing indicate the speed. Consecutive miles are thus indicated. The scale is 28 inches long, passing 4½ times around the cylinder, which is 2⅛ inches in diameter.

The absence of any mechanical connection between the driving mechanism and indicating dial eliminates inaccuracy from wear. The liquid absorbs all vibration. The driving-shaft connections are made above the level of the liquid, and as a farther precaution against leakage the driving pinion of the instrument is fitted with a worm which, when revolving, excludes all oil from the vertical tubular projection of the case.

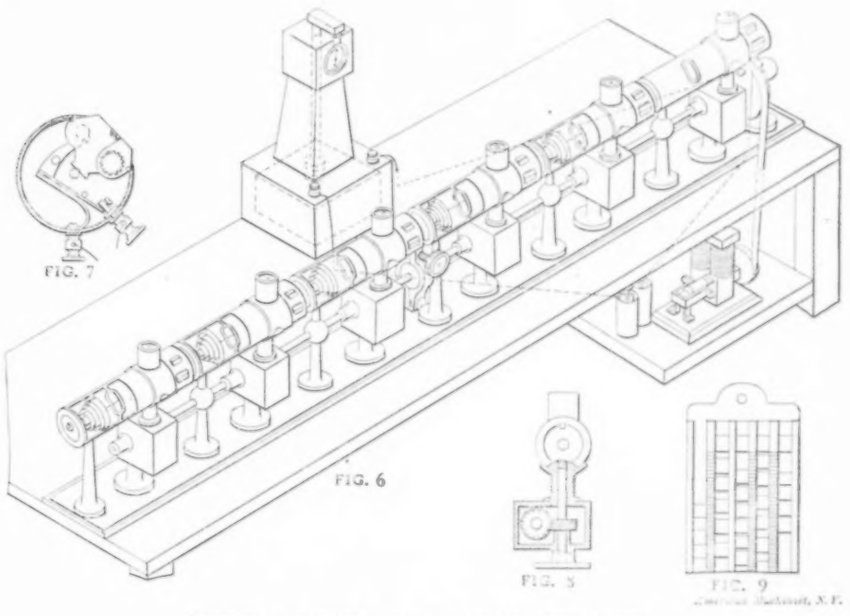
Method of Calibrating

Referring to Figs. 7 to 9, inclusive, the calibrating apparatus is there shown. A series of instruments is mounted on a testing bench and driven by an electric motor under variable control. A stop watch is in circuit with a trip in the power system, and as

$$speed = \frac{distance}{time},$$

and it is possible to read both time and distance accurately, the correct location of each figure on the dial is accurately and individually located. For convenience, the numbers are arranged on a chart, Fig. 9, as they are located. The small figures give an index of position. Later these figures are fastened to the cylinder in their proper places. Thus each instrument is individually calibrated for each figure on its dial. Recording dials also show the length of an individual run and the total mileage of the season.

The instrument is produced by the Casgrain Speed Indicator Company, of Boston, Mass.



TESTING APPARATUS FOR CASGRAIN SPEEDOMETER

Consistency is a jewel and the Honk! Honk! of an auto horn makes the tool clerk at the Pierce-Arrow shop jump just as though he were a plain pedestrian in the streets of Buffalo. It makes a very novel call and shows that someone had an eye for the fitness of things.

Special Tools for Machining Cylinders

Different Styles of Machines in Which Five Separate and Distinct Operations May Be Performed at One Time. Valve Grinding Machine

BY CLAUDE AIKEN

For the machining of Corliss engine cylinders a variety of special tools have been built, the idea of which is more or less applicable to other work and interesting from any standpoint. By means of any one of those illustrated in Figs. 1, 2, 3, 5 and 7, inclusive, a cylinder can be bored and counterbored at each end, the ports finished and reamed to exact size, and each end of the cylinder, as well as the faces of all of the ports, carefully machined. As many as five separate and distinct operations may be in progress at one time. The use of such apparatus insures perfect alinement of all parallel surfaces and that the faced ends are square with the bored parts, the advantages of which are obvious.

While the individual design of each machine varies to a considerable extent, a composite description of one of these special tools might be given very much as follows, and anyone practically interested in the subject can obtain more exact details from any one of the several builders now offering suitable machines. There are three different styles of cylinder-boring machines shown and they are ordinarily designed for handling cylinders of the Corliss type up to, say, 72 inches in diameter and 12 feet long.

The pedestal has a quick travel in either direction, by power, and is arranged so that it may be moved by means of a handwheel for shorter adjustment, with a continuous feed travel in either direction sufficient for boring the longest cylinders of the diameter for which the machine is designed. The boring bars are provided with various sizes of interchangeable cutter heads traveling on the bar by screw feeds. For some machines two bars are furnished, one being of nearly twice the length of the other. Both have hand traverse by rack and pinion to clear the work. The feeds for the cutter arms are positively driven by change gears at the head end but can be released and worked by hand at the other end of the bars. The facing heads or "cat-heads" are clamped to revolving sleeves and may be loosened and swung down when not wanted. On another make of machine the arrangement described farther along has also been found very satisfactory.

The machine is driven by a worm and worm wheel geared at, say, 100 to 1, or any other suitable arrangement, and will give a large number of quick feed changes, varying according to the exact design. The thrust of the worm shaft is taken up with conical roller bearings, which are placed between the hub of the worm and the head of the worm casing. The worm shaft has a double bearing and revolves in bronze sleeves. The boring bar is lapped, and the worm and tail sleeves lap to fit the bar for its entire length and are feathered.

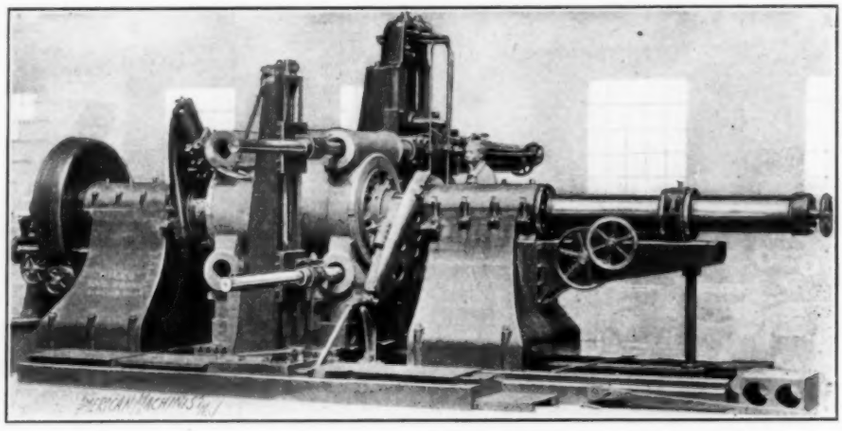


FIG. 2. BORING AND FACING CORLISS ENGINE CYLINDERS AND PORTS

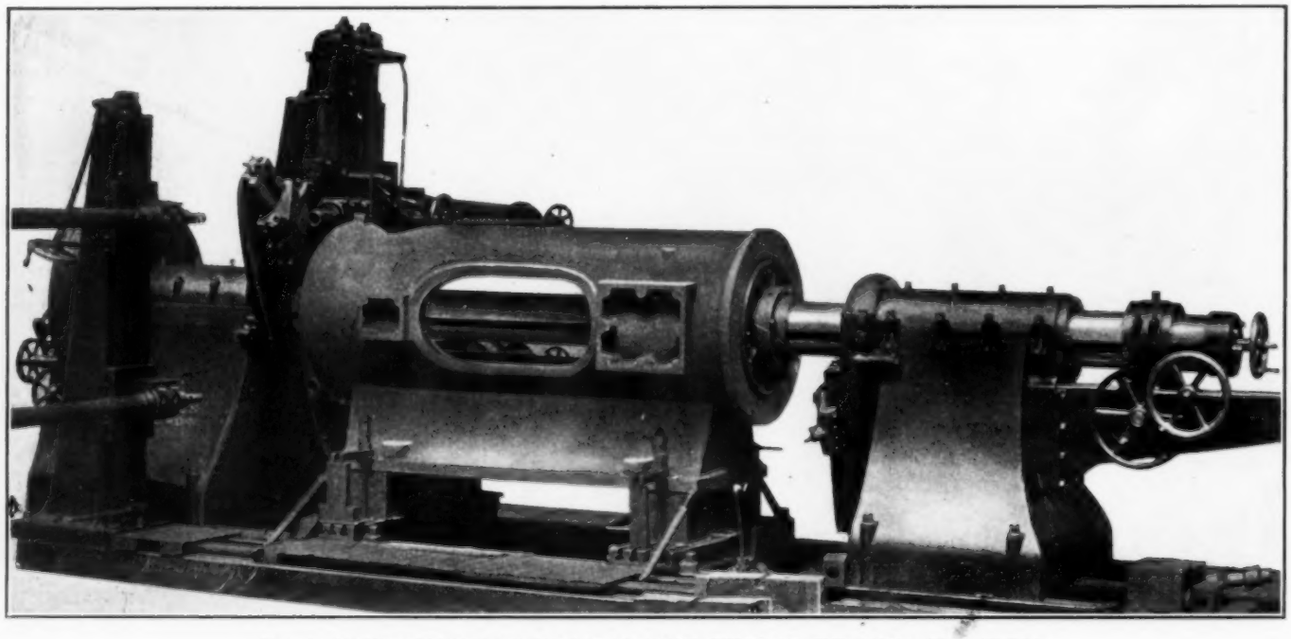


FIG. 1. BORING CYLINDER ON SPECIAL MACHINE BUILT BY THE NILES TOOL WORKS

The outsides of the sleeves are ground and the pedestals scraped to fit.

The tail pedestal is adjustable on its bed by a ratchet lever and in its sleeve is a set screw which can be tightened down upon a feather and the pedestal locked to the bar, whereby rapid traverse of the pedestal on the base is obtained. An arrangement of the facing arms different from that above described is where they are driven by friction and may be started and stopped at will, by simply tightening or releasing collar bolts. These arms are provided with a sliding block, which travels at right angles with the boring bar and is fed in and out by a star feed. Mounted on this is a quadrant block, made in cylinder form on top, which receives a steel plunger for holding the tool. The plunger has a horizontal movement of several inches for convenience in adjusting the tool and turning off flanges of cylinders.

The boring bar may be designed to have a taper held, with draw and drift slots, for admitting smaller bars when desired.

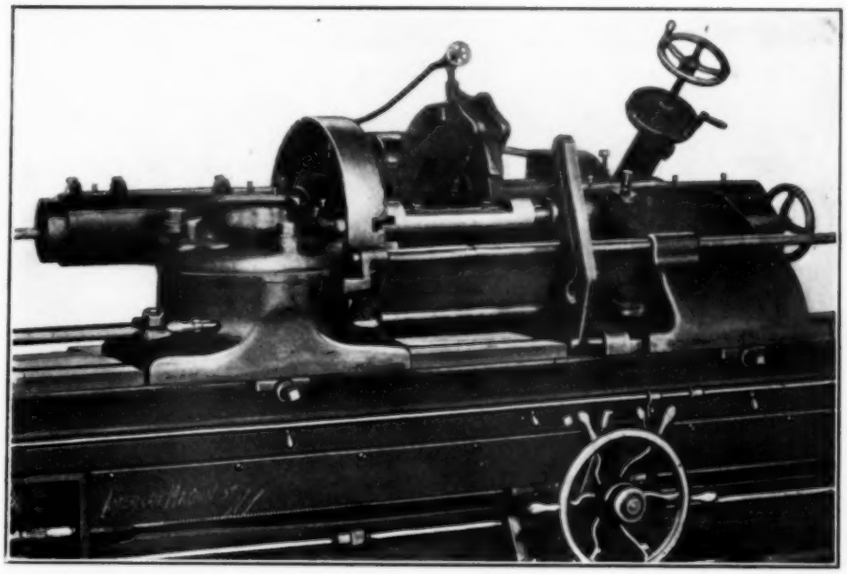


FIG. 4. GRINDING SMALL VALVE ON THE LANDIS MACHINE

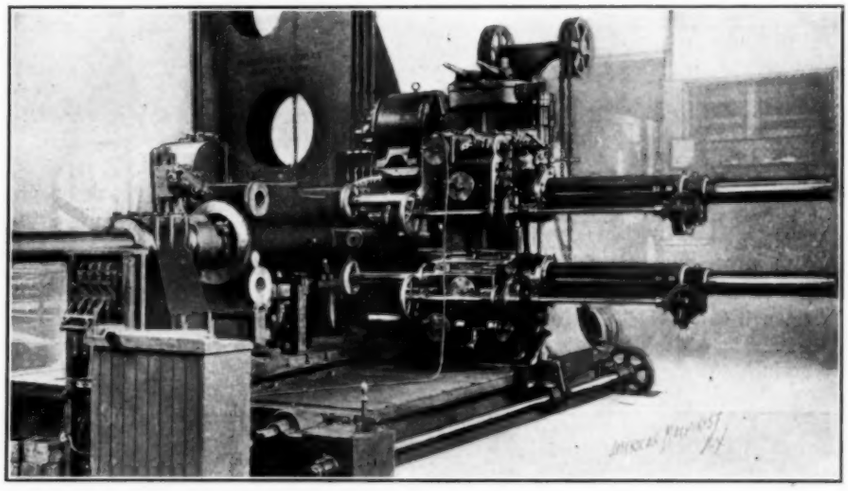


FIG. 3. ANOTHER NILES MACHINE FOR BORING AND FACING CORLISS CYLINDERS

The port boring attachment consists of two columns moving on parallel beds, which have power traverse in either direction. The port bars are movable by power up and down on these column housings, independently of each other, and also have graduated hand alinement, so that the heads can be set to drawing without measurement. Mounted on the larger or main column are two saddles carrying boring spindles to which power is communicated by means of a cone or worm and worm wheels, with ratio of, say, 45 to 1, driven by an independent motor. Like the cylinder-boring bar, each of these spindles has a taper hole in the end for inserting smaller bars when desired. These spindles, by manipulation of a suitable clutch mechanism, can be operated together or not as desired. They have several quick feed changes, a feature of which is that these are entirely independent in operation; that is, 1/32 inch can be used on one bar and ¼ inch on the other simultaneously. Quick traverse by hand is secured through hand wheel, pinion and rack. The rear or smaller column carries spindles in two outboard saddles, and the general arrangement is similar to the other, except that the vertical adjustment is by hand.

For operating the boring bar and accessory mechanism of a 60-inch-cylinder machine the power used is about 10 horsepower, with an additional 8 horsepower for the port boring attachment, but the sizes of motors needed must be determined by the requirements of the work, as the maximum is seldom called for except very temporarily. In asking builders for information concerning any tool of this character which it may seem desirable to install, considerable misunder-

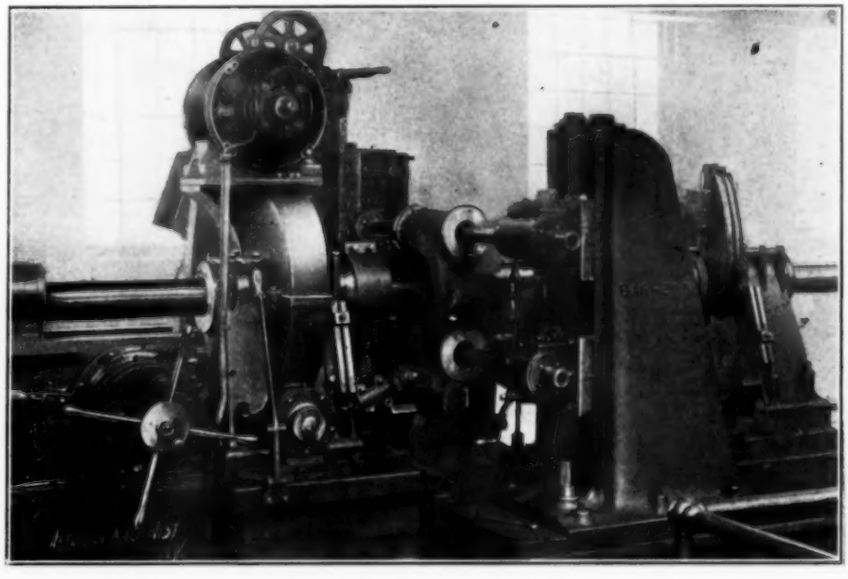


FIG. 5. ANOTHER VIEW OF THE BARRETT CYLINDER BORING MACHINE

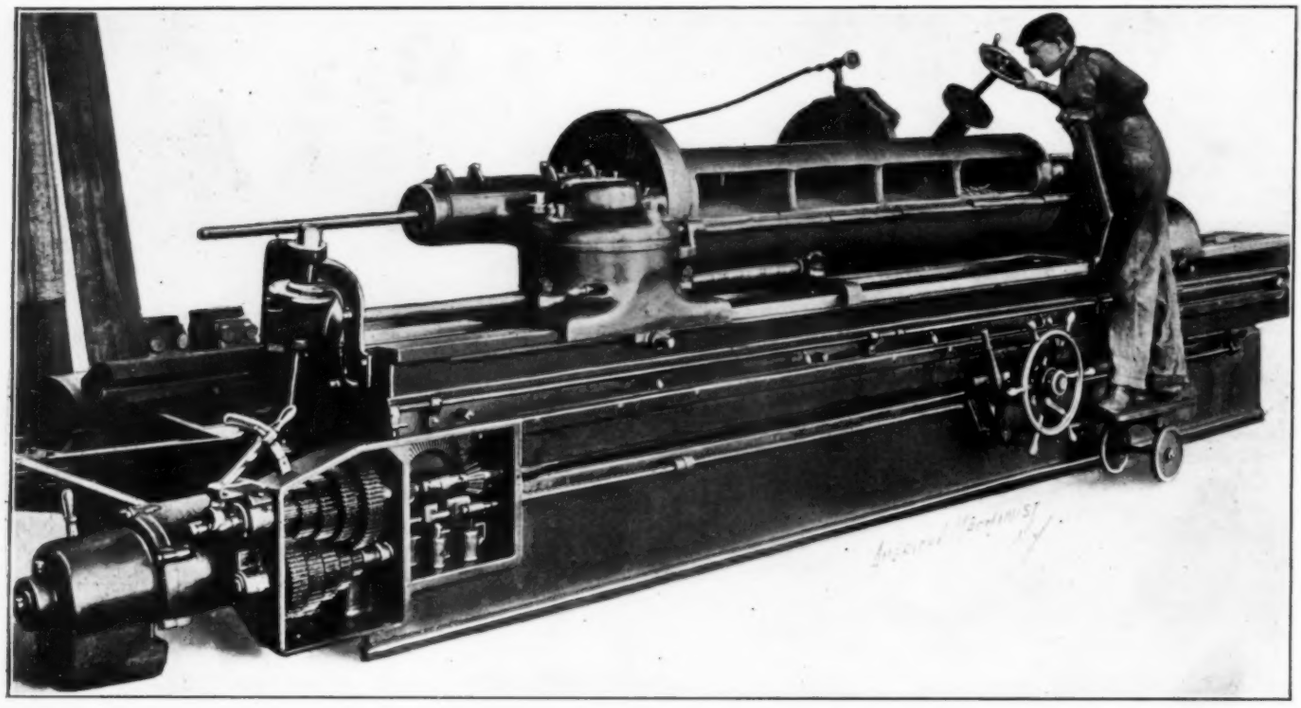


FIG. 6. GRINDING LARGE VALVE ON SPECIAL MACHINE BUILT BY THE LANDIS TOOL COMPANY

standing can also be avoided by making plain the requirements of the work for which it is intended. Some of the features above mentioned are patented and cannot be generally used; but the various makers have worked out several combinations which give approximately the same results, and the machines built on specificationsparticularly adapted to the service required of the tool have given excellent satisfaction, as far as the writer personally knows.

Grinding Operations on Special Machine

In Fig. 6 is seen the valve which fits the cylinder. This valve is being ground on the Landis self-contained grinding machine. The range of work which this machine will do is shown by the comparison of the large valve being ground in Fig. 6 and the small valve which is being ground in Fig. 4. The largest of these machines has a 30-inch swing, and is 198 inches between centers. It will carry a grinding wheel with a diameter of 30 inches and a width of from 1½ to 4 inches. A taper of 2½ inches to the foot can be ground on the large machines, while on some of the smaller sizes as high as 4 inches to the foot is obtained and they will handle any class of work that can be revolved on two dead centers. As these machines are so well known, a further description of them is hardly necessary.

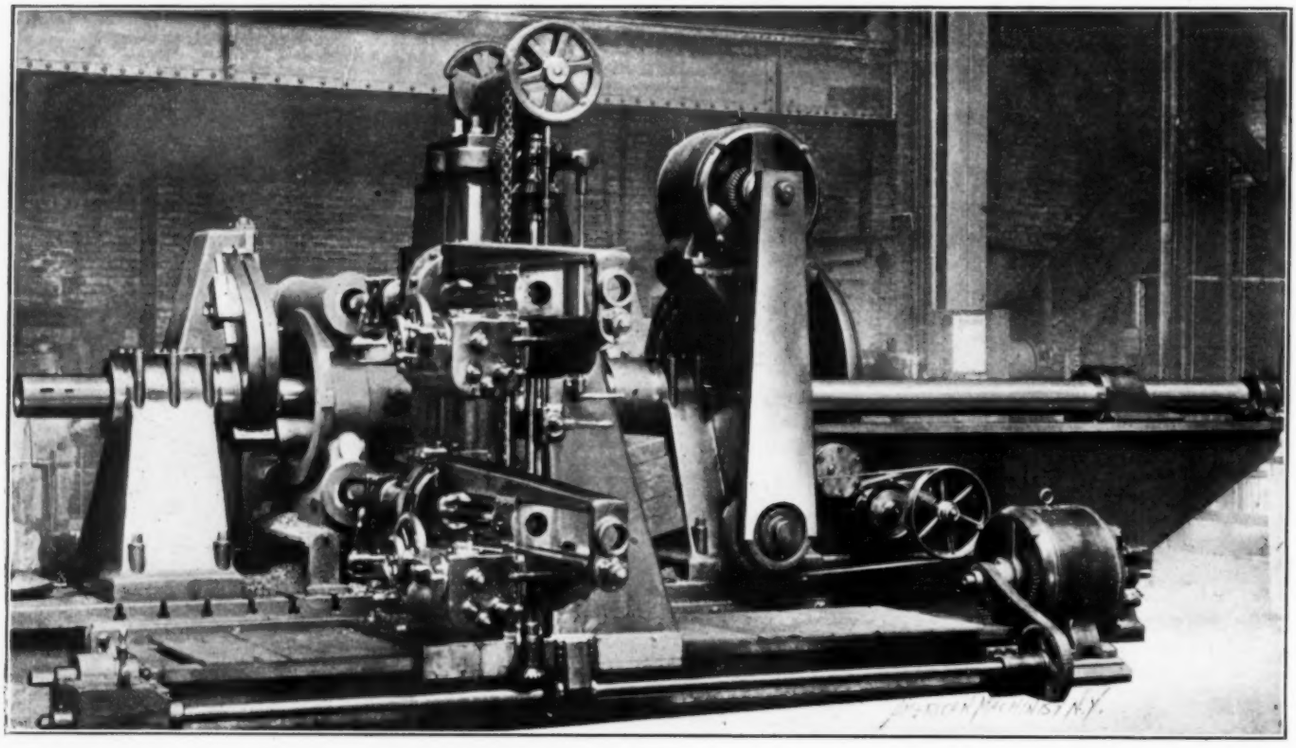


FIG. 7. BORING AND FACING CYLINDER AND PORTS ON SPECIAL MACHINE BUILT BY BARRETT MACHINE TOOL COMPANY

Interesting Railroad Shop Methods

EDITORIAL CORRESPONDENCE

One of the largest railroad shops in the country, considering the amount of new machinery and rolling stock built, in addition to the repairs on an extremely long line of road, is that of the Chicago, Milwaukee & St. Paul railway, at West Milwaukee. These are in charge of S. M. P. Manchester and M. M. Winn, while an able corps of general foremen keep the work moving and are constantly devising new and improved methods for doing the work in hand. Some of their achievements in this line are extremely interesting, and a few of them are given herewith.

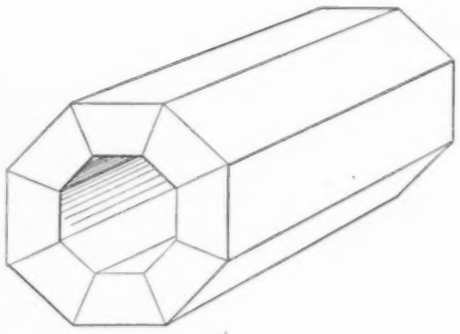


FIG. 2

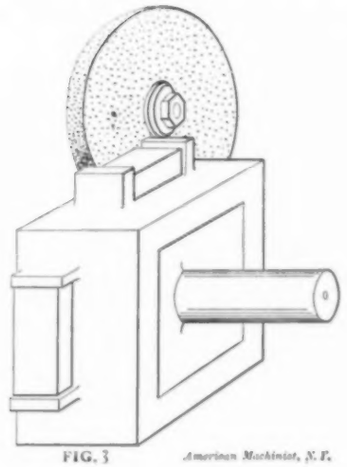


FIG. 3 *American Machinist, N. Y.*

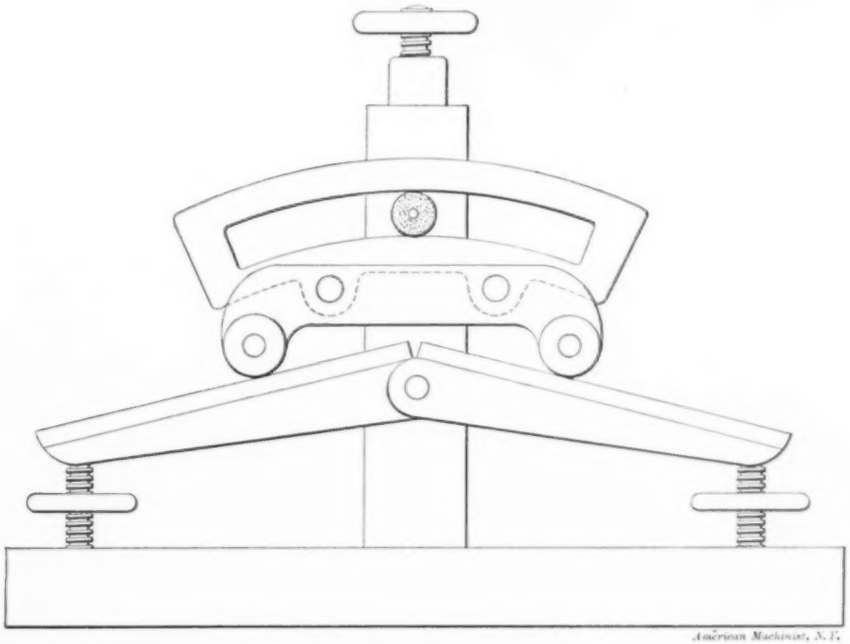
MAKING TUBE EXPANDERS

USE OF BORING MILLS

The vertical boring mill is used extensively, ranging from the fairly heavy work on the large locomotive driving boxes down to quite small rod bushings, such as are usually done in the lathe. Two small machines are used for this and are run at a speed that gets the work out in quick time.

Piston rings are turned, bored and cut off on a boring mill, the cutting off being done with a gang tool, as in the lathe, held in one of the tool slides, run down beside the ring barrel and fed into the work by hand. This has been found more satisfactory than power feed for cutting off and, though the mill looks light for the work, it has been doing it for a number of years.

In this connection it is interesting to note the allowance made in turning rings. The rings are rough-turned about 3/8 inch larger than the cylinder, then cut apart, the ends milled for a lap joint of, perhaps, an inch, sprung into a fixture and clamped between follower plates for the finish turning. They are now turned 1/16 inch smaller than their cylinder, allowing this for spring, to be entered in the cylinder.



American Machinist, N. Y.

FIG. 1. A LINK GRINDER

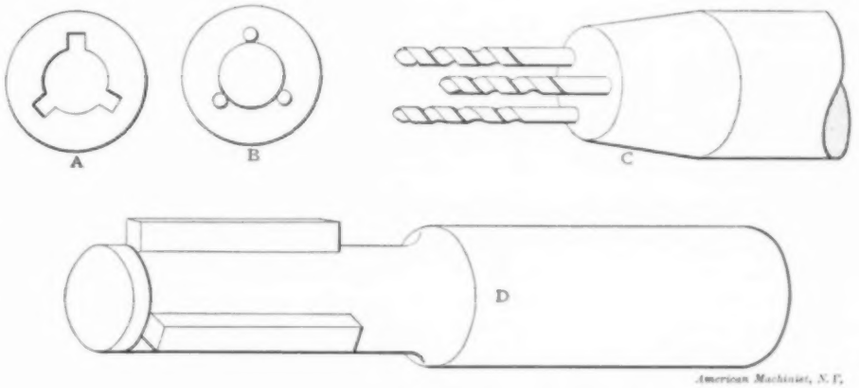
BROACHING VALVE BUSHING PORTS

Finishing the valve ports in piston-valve bushings becomes quite a problem, as there are many of them in each bushing. Some shops mill them with a small diameter cutter, about 3/4 inch, but this leaves a 3/8-inch radius in each corner and this counts up in area when all the ports are considered.

To avoid this and get the full opening in each port, the plan here is to work them out on a shaper with a traveling head. The bushing is mounted on a special fixture with stops to locate it for each set of ports, and a broaching tool is put in the tool post, of such shape as to cut out the corners and the sides of the ports at will. Both "pull" and "push" broaches have been tried and there is a tendency to use the latter on account of its being easier to handle the broach in the machine. They make a very good job and do it in good time.

PRESS FITS ON AXLES

After a careful man gets used to press fits he can tell pretty near what pressure will be required to force the wheels on



American Machinist, N. Y.

FIG. 4. A NEAT TURRET JOB

the axle. One of the men in this shop is an expert in this line and can tell within a very few tons what pressure will be required to force home any wheel. The practice is to turn the axle and the wheel seat to a taper of 1/32 inch in about 8½ inches and with this taper the allowance on a 10-inch axle is about 0.01 inch for a new wheel or 0.007 inch for a wheel that has been pressed on one axle and removed. This is because the metal of the hub will not compress as much after the first pressing. With this allowance, from 140 to 150 tons pressure is required to force it home.

A very small difference in diameter makes a big difference in the pressure required. Increasing the pressing allowance from 0.01 inch as above to 0.012 and the pressure is likely to sum up to 200 tons, while reducing the allowance to 0.007 inch for a new wheel will probably reduce the required pressure to less than 100 tons.

These are for hammered iron axles, for steel the allowance is less, on a 10-inch axle being about 0.008 for a new wheel and 0.005 for the second pressing. Car-wheel axles on this road have a taper of 5/64 inch in 7 inches and on a 5-inch axle the pressure used is about 40 tons.

A Link Grinder

A novel form of a link-grinding machine is shown in outline in Fig. 1. It consists of the grinding head carried on the vertical column at the back and a frame consisting of two sets of V-tracks hinged in the center and adjustable at the outer end by the screws and hand wheels shown.

The link to be ground is mounted by its hanger holes in the carriage or truck. The tracks or ways are adjusted to the right angles to give the desired radius as it is moved back and forth, one end going up and the other one down as it is pushed back and forth by hand, the combination giving the curve of the radius desired for the link.

For grinding the block there is an attachment which goes on the back of the carriage, holding it by its pin hole and allowing the proper curve to be ground in the same way.

The grinding head is adjusted to secure the proper location of wheel for either internal or external work, automatically tightening the belt at all times, and the whole machine has an air of simplicity and effectiveness.

Making Tube Expanders

The tube expanders used on this system are of the swaging type and consist of eight pieces around an octagonal taper arbor which is driven in to expand the segments. The usual way to make these is to turn them up from the solid and saw them apart, then to plane, mill, or grind the inside to fit the octagonal arbor. In this shop they go at it in a different way. Steel is bought drawn to the right section so that eight pieces will fit together as shown in Fig. 2. These are cut off to the right length, and are then ground on the sides and the narrow edge on an attachment to grinding stand shown in outline in Fig. 3.

A sort of a square, vertical turret is mounted on the grinding stand, each face carrying a different fixture and all allowing the pieces to be ground to the right angles without measuring or difficulty of any kind.

They are then assembled around an arbor having collars for holding them in place after they have been centered by a clamp consisting of a ring with eight set screws. Then they are turned to the prescribed shape on the outside and are ready for business at a remarkably low cost.

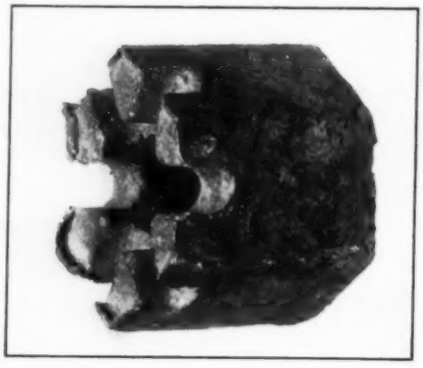


FIG. 5. CASTLE NUT IN THE ROUGH

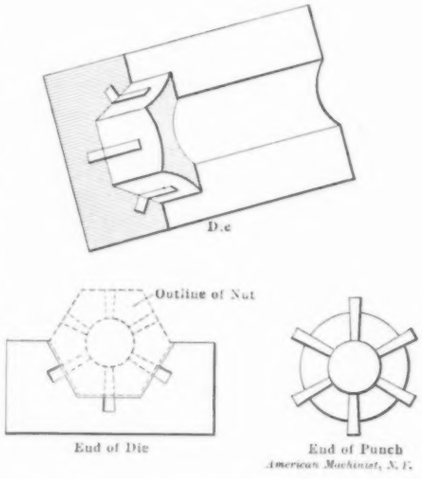


FIG. 6. PUNCH AND DIE FOR CASTLE NUTS

A Neat Turret Job

A very neat turret job in this shop is the making of a special nut for a Sellers injector something as shown in Fig. 4. This is not cut clear through but has a back on it which makes it rather a mean proposition to cut the three slots shown.

The first operation is to chuck and bore the hole as deep as required. Then an eccentric recessing tool reaches in and makes a recess at the back to allow for the tap and the slotting tool.

Next comes a very ingenious application of an air drill invented by the tool-room foreman in which the whole drill goes right into the turret and drives the three drills shown at *C*. These are properly located to drill for the three slots and are each driven by a small gear inside the holder. This holder screws on the nose of the air drill which carries a small pinion in its regular drill chuck, this pinion going in the center of the three gears and driving all three at once. This tool puts in the three holes spaced equidistant, and makes ready for the breach or punch which follows.

This is the next operation, the tool, as in *D*, having a short pilot to enter the bored hole and the three blades which broach the slots to finished size at one cut. This tool is also carried in the turret and is simply forced into the nut by the operator. After this, the top is run in and the job is completed.

Making Castle Nuts

Castle or castellated nuts, nuts with slots across the hex to hold key or cotter pins, are coming to be used quite extensively in locomotive practice. The old way was to make an extra long nut and mill the slots in across the head but Mr. Bennett, the general foreman of the smith shop has that beaten to a frazzle. Fig. 5 shows a nut just as it comes from the bulldozer where it is made at one operation just as shown, all the pins it produces being shown in the illustration.

These are made by gripping round stock in the lower part of the dies and then forcing in the punch shown in Fig. 6. The end of the punch goes a little deeper than the length of the nut so that they are easily cut off by a pair of knives on the side of the machine itself.

The dies are simple, the hex nut being formed by the shape of the die above the gripping portion, and the six punches for the slots, extending beyond the nut and working in grooves in the die itself.

The first dies had the punches flush with the outside of the nut and left a fin that had to be trimmed off before the cotters could be used but the new dies leave the nut practically without fins and only needing to be tapped and faced to make them ready to use.

The making of tinplates originated in Bohemia, according to a recent paper by William E. Gray, hammered iron plates having been coated with tin in that country some time before the year 1600. Tinplate making was introduced in England in 1665, the art being brought there from Saxony. In France the first tinplate factory was established in 1714. The first commercial manufacture of tinplates in the U. S. was at Pittsburg, in 1872.

Relation Between Rotative Speed and Bearing Surface of Journal Bearings

By A. M. Bennett

In the design of bearings, or their selection to fill some special requirement, the importance of taking into account the surface or peripheral speed of the rotating journal, in connection with the load on the bearing, is frequently not realized. That this is a necessary factor in determining the required bearing area for any case can be seen, when we consider that the friction developed between a bearing and its journal varies directly as the surface speed of the latter, that this friction manifests itself in the form of heat, which has to be dissipated by radiation from the outer surface of the bearing and its retaining parts and by conduction along the shaft itself. It is evident, therefore, that when the heat developed per unit of bearing area exceeds the amount that can be effectively got rid of in this manner, the bearing will overheat; to prevent this, it is necessary that the two factors determining the heating, viz., pressure and speed, be so related that the friction developed always has a definite relation to the bearing area.

We frequently see an attempt made to take account of this factor of speed by setting a limit of a certain number of pounds pressure per unit of bearing area, which is not to be exceeded in bearings running up to a specified number of revolutions per minute. Even with this rule one is not absolutely sure of producing a safe condition; for, assuming a bearing of a size that is known to have too high a pressure in pounds per unit of area for a given speed, if the attempt is made to lessen this pressure by the use of a bearing of larger diameter, the length at the same time not being increased, we do not change the result as might be expected, and the bearing is no safer than before. The pressure per unit of area has been decreased, but the peripheral speed of the journal has been increased in like proportion, and with it the loss due to friction. The result as far as the amount of heat generated per unit of bearing area is concerned, is not changed. There is also the disadvantage of increased power required to overcome the increased friction loss.

The above rule, therefore, must be changed to take into account the peripheral speed of the journal rather than the actual revolutions per minute; if we make the product of the peripheral speed and pressure per unit of area equal to some constant, we have a rule for proportioning bearings at different speeds and loads that will always give like conditions so far as heating is concerned. Calculations based on a large number of bearings that have come under my observation and that are known to operate within a temperature rise of 40 degrees Centigrade, show that if the peripheral speed be taken in feet per minute, and the pressure in pounds per square inch of projected area, this constant for the ordinary self-alining, ring-oiling bearing can lie between the limits of 36,000 and 40,000. Using the smaller value to be on the safe side, and letting

N = Revolutions per minute,
d = Diameter of bearing in inches,
l = Length of bearing in inches,

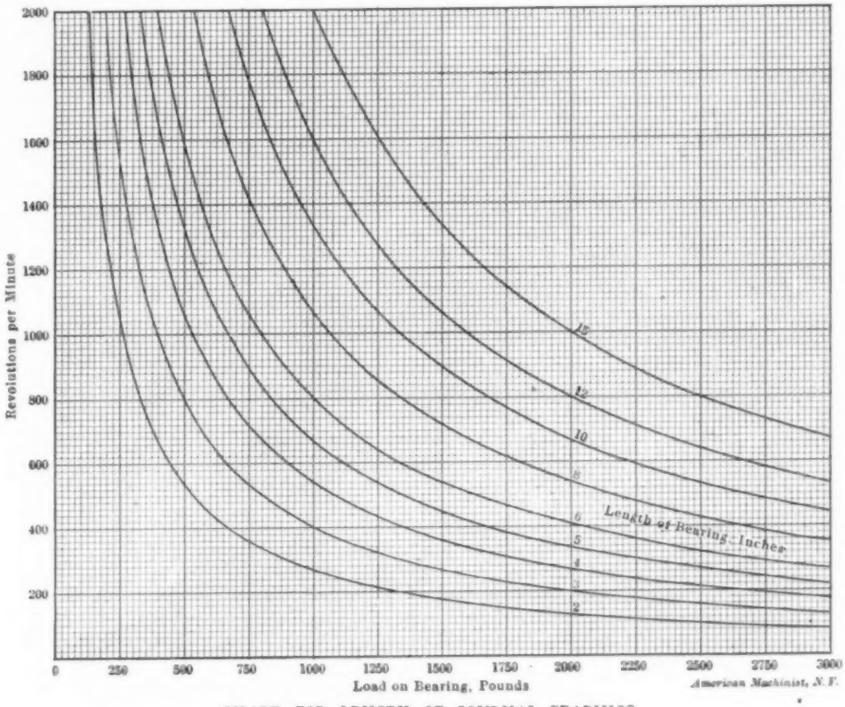


CHART FOR LENGTH OF JOURNAL BEARINGS

L = Total load on bearing in pounds;

we have,

$$\frac{\pi d N}{12} \times \frac{L}{d l} = 36{,}000,$$

which reduces to

$$\frac{N L}{l} = 137{,}000.$$

That is, if the product of the revolutions per minute and total load on the bearing, divided by the length of bearing, does not exceed the constant given, the bearing will operate at a safe temperature, provided the oil supply is not restricted in any manner and the bearing surfaces are in good shape.

The curves shown in the accompanying diagram have been drawn with the view of presenting this formula graphically, and in a manner more convenient for use. The curved lines represent the length of bearing, while the revolutions per minute and load are plotted at the side and bottom of the diagram, respectively. From these curves we can readily determine the length of bearing for any condition of speed and load within the limits of the diagram; the diameter of bearing is generally determined by the required size of shaft. With a given diameter of bearing we, therefore, choose the length to suit the conditions of load and speed.

In estimating the load on the bearing, if there is a belt pull or a gear thrust in addition to the load due to weight, this, of course, must be taken into account and the load which is a resultant of the two, used for the actual load on the bearing.

As was pointed out previously, an increase in the diameter of the bearing at a given length does not lessen the heating per unit of bearing area. This explains what may have been noted, that the factor representing the bearing diameter does not enter into the formula in its final shape.

The formula as given is for bearings working under a steady load, such as a continuous downward pressure, or a belt pull. There are cases, however, as in the main bearings of reciprocating engines, where the resultant line of pressure on the bearing is continually shifting; in bearings of this nature the constant in the above formula can be changed, as under these conditions there is always more or less of a pumping action on the film of oil between the bearing and journal, which insures a better supply of oil through the bearing. The latter for this reason, and because the pressure or thrust is not confined to one section of the bearing, will run cooler under a like amount of load, than where the pressure is constant in one direction.

According to an English contemporary if very thin aluminum foil is ignited, it burns with a brilliant white light, and the oxide thus formed is as hard as corundum, and may be used for polishing the hardest steel.

Practical Letters from Our Readers

A Round Table Discussing Details of Modern Machine-shop and Drawing-office Methods, Practice and Economy

WE PAY FOR USEFUL IDEAS

Some Results from an Ultra Capital Steel Lathe Tool

A few days ago I got hold of a piece of the new steel, "Ultra Capital," and being a little skeptical of the results of others, as described in some of the technical papers lately, I decided to test it for myself. I carefully forged and hardened the steel as advised by the instruction card. It was very easy to forge, and could be hardened in water.

After getting the tool ground nicely I tackled a set of badly worn car wheels 24 inches in diameter. These wheels were of hard cast iron and were worn badly; in some places, being ⅜ inch higher than in others. I started the lathe at 108 feet per minute and finished one wheel all over, including the flange, without seriously affecting the tool.

I then decided to try two other steels that we think good, on the next wheel at the same speed. The first tool stood for two cuts across the flange, about ¾ inch wide, and burned so it was unfit for service without regrinding. The second tool gave out with one cut across the flange.

I then put in the ultra capital tool and finished that wheel and the next two at the same speed of 108 feet per minute. From ⅜ inch to scraping the sand was the depth of the cut, as I wanted only to true the wheels up. This was a very severe test on the cutting edge of the tool, as it had to scrape over the sandy scale for a part of the circumference on each one of the four wheels.

The next test was on cast-iron core gudgeons 14 inches in diameter and 10 inches long. We ran the tool on these castings for five hours at speeds ranging from 124 to 165 feet per minute; depth of cut, ⅛ inch, and a feed of 1/32 inch. During the five hours the tool was ground twice. It was dulled by sand crystals in the iron, and I believe if the iron had been clean it would have run the five hours without regrinding.

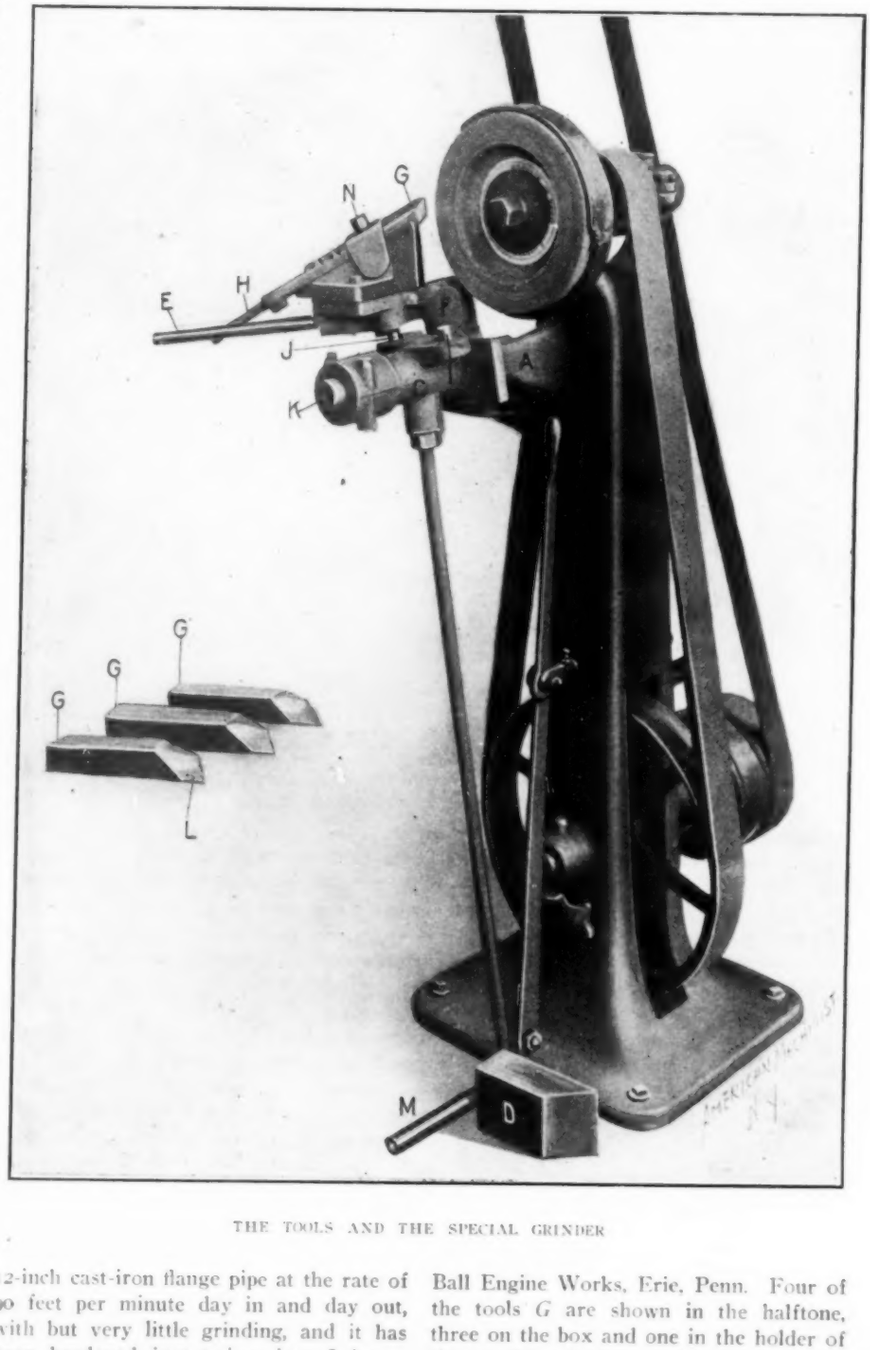
Some soft-steel bands 12 inches in diameter were being turned in the shop at a speed of 42 feet per minute, a cut ⅛ inch deep and 1/32 inch feed with a modern high-speed steel, and that was all the tool would stand. I suggested that we use the ultra capital tool and try to burn it up. We started with a speed of 125 feet per minute and ran the tool for three solid hours without regrinding or hardening of any kind.

The speed was then increased to 150 feet per minute with the same depth of cut and feed and the tool ran for two hours more. The back of the lathe looked like a Western straw stack, the shavings piled up so high. At present that same tool, which is 5⅛x2x10 inches, is facing 12-inch cast-iron flange pipe at the rate of 90 feet per minute day in and day out, with but very little grinding, and it has been hardened just twice since I began using it, about three weeks ago.

Radford, Va. FRED E. MYERS.

A Universal Tool for Lathes, Planers and Boring Mills

This tool, described in the heading, is at present in a state of evolution at the Ball Engine Works, Erie, Penn. Four of the tools *G* are shown in the halftone, three on the box and one in the holder of the special grinding machine. The tools are made of high-speed steel. The steel is 1 inch square.



THE TOOLS AND THE SPECIAL GRINDER

The grinder on which these tools are shaped by a boy is practically fool proof; that is, the boy cannot make a mistake, as each tool will be ground exactly like every other one.

The base is cast with a bracket *A* having a horizontal spindle *K* on which swings the grinding fixture in which the tools or cutters *G* are secured. The face only of the cup emery wheel is used for grinding and this face is dressed and adjusted so as to be in line with the face *B* of the bracket which bears a fixed relation to the center of the horizontal swinging frame *F* which is controlled by the handle *E*. The pin *J* on the swinging frame *F* coming in contact with stops, one only of which *I* is shown, limits the arc of the travel of the swinging frame *F*. This motion rounds the point of the tool. The face *L* of the tool *G* is ground with the horizontal swinging frame *F* in practically the position shown, that is, with the pin *J* against the far stop which is obscured from view in the halftone. Motion is given to the tool by the operator's foot on the cranked end of the foot lever *M*. Swinging this back and forth, from its position against the wooden stop *D*, rocks the bracket *C* pivoted on *K* and with it the frame *F* to which the tool holder is secured. End adjustment for the tool *G* is by means of the set screw *H* which is provided with a lock nut to keep it from jarring loose.

A simple clamp and nut *N* hold the tool *G* securely in the holder. In use these universal tools will be secured in holders designed for the requirements of the various machine tools in which they are to be used. The holder for the planer will present the tool to the work at the most advantageous angle for that particular machine and the holders for the other machines will be so designed as to get the best results out of the tool.

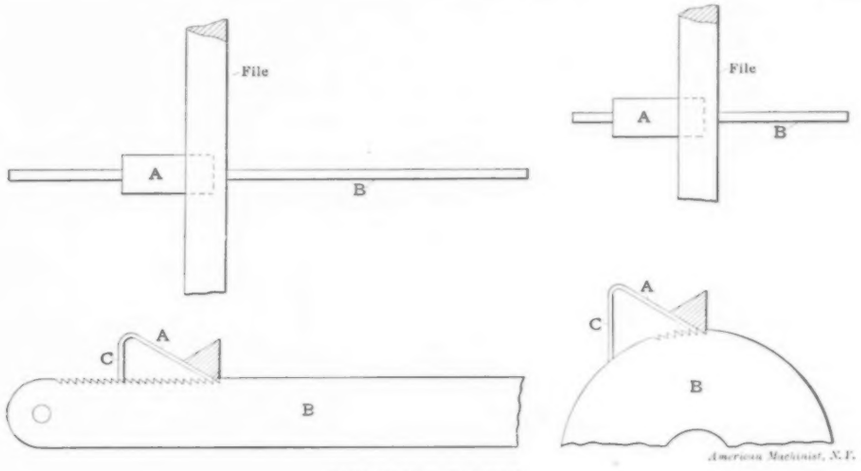
This is merely the beginning of a system which will probably result in the elimination of a lot of special tools suited for but one machine, and it is expected that ultimately a few standard shapes of tools will be evolved which with standard holders will make them equally useful on the lathe, planer, or boring mill.

New York. E. A. DIXIE.

A Saw Making Kink

It sometimes happens that one saw has to be made to do a special job. Mounting it in the milling machine to space and cut the teeth is quite an expensive job, if only one saw is required and spacing the teeth with a file by guess usually means very irregular teeth.

A friend recently put me on to the following method of spacing and filing the teeth with the aid of a jig. The filing jig is shown at *A C* in the cuts. It is made from a piece of sheet steel about ¼ inch wide and 1⅛ inches long. For filing hack-saw blades the leg *A* is twice as long as the leg *C*. Thus the side *A* is at 30 degrees when the jig is laid on the blade.



SAW MAKING KINK

For circular saws the leg *C* will require to be longer or the teeth will be much undercut. The proper length for the diameter of saw blank can be easily calculated or determined by experiment. The method of operation is as follows:

Flatten one side of a three-cornered file on the emery wheel. Hold the leg *C* in the left hand, and place on the blank, as shown in sketches. With the dull side of the file on the leg *A* file the first tooth. Do not file quite to the full depth. Move the jig on from left to right until the end of leg *A* drops into the filed notch and file the second tooth, and so on, until all the teeth have been spaced. The teeth can now be pointed without the aid of the jig, or the jig may still be used for that purpose, but working backward, that is, from right to left.

The relationship between the thickness of the stock of jig and the spacing of the teeth is as 1 is to 2. Thus, if we require 20 teeth to the inch in the saw, the jig stock should be 0.025 inch thick.

Brooklyn, N. Y. F. J. B.

Learning a Trade in Middle Life

The other evening I overheard a conversation between two young men about like this: "Say, do you know, there's a tech fellow coming in to work beside me tomorrow morning."

"What's he get?"

"Dollar and a quarter a day, like the rest of us."

"A feller's a fool to go to that place; he'd better go to Harvard and get on the ball team; then he could get a good job when he came out."

That set me to thinking. Of course, these boys were not very deep; they couldn't be expected to see that the ball-player's period of usefulness is limited and the engineer's is likely to develop indefinitely, but it is not surprising if they saw that a young fellow could get more money as a ball player, or a chauffeur, or in some way connected with sports than if he was an engineer. I cannot help but wonder how large an influence sports are having on our young men to keep them away from permanent trades. These boys' parents almost always try to keep them from the sports, but the easy money, the excitement, the risk all combine to set their blood tingling, and off they go. When one of them gets his fill of ball playing, which comes as soon as he loses his youth, he is ready to turn to something substantial only to find that he is too old to serve an apprenticeship, and that most employers think a man of 25 or 30 a failure if he has no trade or settled occupation at that time.

I cannot see why employers so often seem to think that a shoemaker should stick to his last. If a man, matured, is willing to try to change his trade, or learn a new one, I feel that he is taking the greatest risk and going to the most trouble. I have had experience with several of these cases that have turned out well.

I met one the other day. He *was* a shoemaker, too, as it happened. He got sick of his last, although in rush times he was making good money. He came to town and hired out as nothing in particular except a good-natured two-legged animal. He caught on rapidly. When he left that shop and came to me I thought he was a planer hand. We did not have enough work to keep the planer going, but we did have some lathe work. I soon found that he was bluffing on the lathe, but it was such a good bluff and he was so eternally good-natured that I held my tongue. After a while I found I had to have the planer going all the time, so I hired a real planer hand. I found this chap had been taking a correspondence course and was making himself so valuable that it was easier to keep him on a lathe. There were intervening stages, one when I fired him for being so durned good-natured that he whistled too much,

but the last chapter of the story is, he is now master mechanic of a shop of some considerable size on a class of work where if he had not done about every conceivable kind of work himself he would have been stumped.

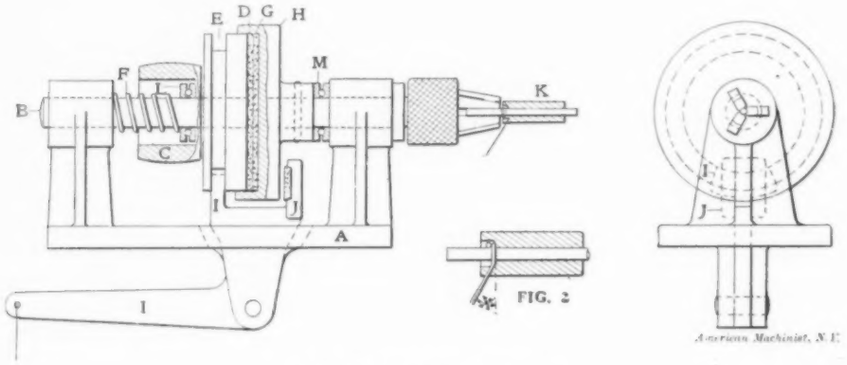
This class of men can and do benefit from evening trade schools, but not nearly so much as they might if the trade-school people realized what they needed more. The general run of evening trade schools, take those here in Springfield, for example, give as their object just what these men want, the enlarging of their scope in the shop; that is, the making of them into all-around men. But when they give their courses it seems that their principal idea is to give them a broadening, general education which is very well, and then to give them mathematics and drawing, etc., relating to the trades, but to leave their shopwork largely to chance. I feel that these schools ought to be able to call in men from various shops, something as a consulting engineer is called in, to spend a few evenings with any group of men who need special care in any one line of work. Suppose a man comes along who thinks there is a foremanship ahead of him if he knew only how to set up automatic screw machines. Your trade school ought to be able to borrow a second-hand screw machine of the type he wants to know about and bring in a man who is an authority on that work for an evening a week to supplement the work of the regular teacher. Of course, the reason why that is not done is because teachers are afraid that their limitations will become known, which is a poor argument, for they will become known anyway. It is much better for them to say at the start with their classes that they do not know it all and never expect to, than to go along under false colors and get caught. A family physician makes no bones and feels no disgrace in calling in a specialist in case of need, and I know no reason why a regular teacher should not feel that he is doing better by himself, his pupil and his employer to call in expert assistance when he finds that he is beyond his depth.

Springfield, Mass. ENTROPY.

A Spring Winding Machine

While there are a number of automatic spring-winding machines on the market more or less complicated in construction, this simple but effective device for winding small springs may be of interest. It consists of a cast-iron bed *A* supporting the spindle *B*. The pulley *C* is loose upon this spindle. The pulley *C* has a flange to which a leather disk *D* is fastened and also has a groove *E* to receive the release lever *I*. The spring forces the pulley forward to engage the leather disk *G*, which is fastened to the drum *H*. This drum is secured to the spindle and causes the spindle to rotate with the pulley. To stop the machine it is only necessary to disengage the leather disk and this is done by a pedal attached to the lever *I*. The line cut shows the disks separated. The arm *J* acts as a brake on the drum when the pedal is forced down far enough. The parts *L* and *M* are thrust collars. To wind the spring the wire is started on the mandrel, the sleeve *K* is slid over the coil and the pedal released. An enlarged view of the sleeve *K* is shown in Fig. 2. This sleeve insures a uniform tension in the spring. It is counterbored larger than the outside diameter of the spring and fits over it to prevent piling. A cut is made through the counterbore to guide the wire. The angle *X* of the cut determines the initial tension of the spring.

Derby, Conn. F. EBEL.



A SPRING WINDING MACHINE

How is Iron Cast Around a Brass Name Plate?

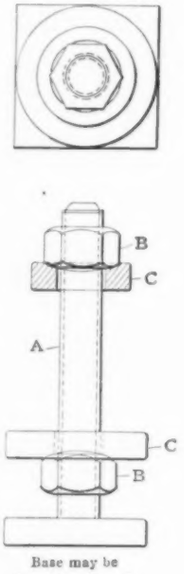
We wish to cast brass name plates in depressed panels in iron castings. The brass plate is to be made first and laid in the mold and the iron cast around it. So far we have had no success.

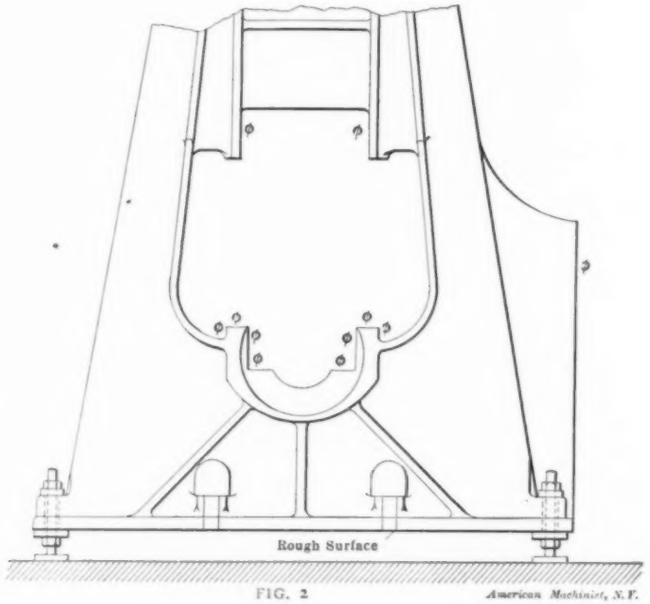
Rochester, N. Y. A. L. M.

A Leveling Jack

The line cut shows a convenient leveling jack we are using in our works, for leveling up heavy columns and other similar castings, which has been found very satisfactory for the purpose for which it was designed. It consists simply of a heavy screw (see Fig. 1) *A* with a large head or base. This screw carries a pair of nuts *B*, which are provided with washers *C*, both nuts having convex surfaces working in concave surfaces in washers, making ball-and-socket joints so that the washers can adjust themselves to the rough cast surfaces.

The column being once leveled up (as shown in Fig. 2) can be quickly shifted on planer or floor plate without releveling.





A LEVELING JACK

just as though the lower surface were machined. The lower surfaces of these castings are not machined, and they must be moved on their base for the different operations. The column is clamped to the planer table after being properly located in the usual manner.

Waynesboro, Penn. F.

Fixture for Drilling Holes at Right Angles to the Spindle

Figs. 1 and 2 show, respectively, elevation and plan of a device for drilling holes at right angles to the drill-press spindle for valve rods and stuffing boxes. This device has been in use by me for more than a year and gives satisfactory results on a job which we formerly did with the ratchet brace. *A* is the drill-press spindle, *C* is a pair of bevel gears; the one upon the horizontal drilling spindle is provided with a feather which slides in the spline in the milling spindle. *D* is a block to fit in the valve-block slide. *E* is a hand wheel threaded to fit the feed screw. *F*

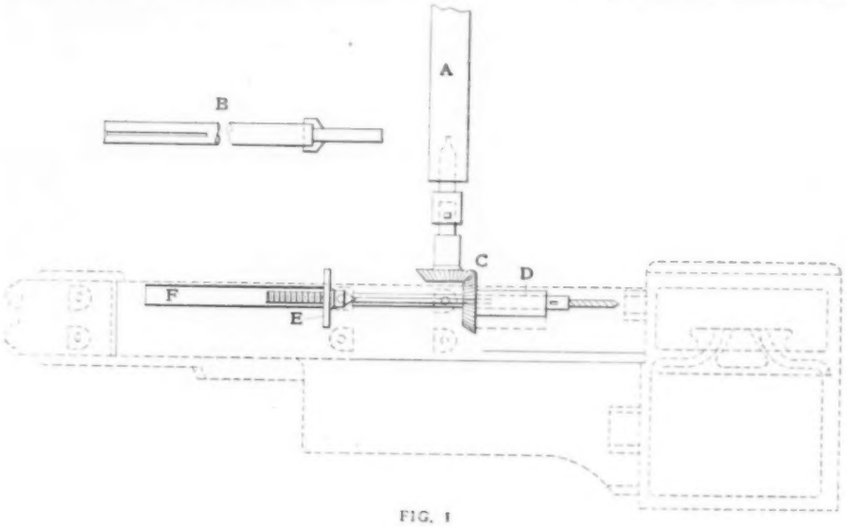


FIG. 1

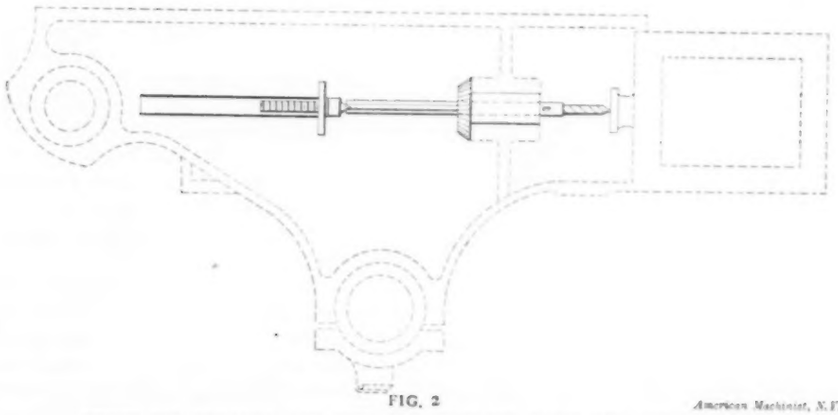


FIG. 2

American Machinist, N.Y.

DEVICE FOR DRILLING AND COUNTERBORING FOR VALVE ROD AND STUFFING BOX ON ENGINE CYLINDERS

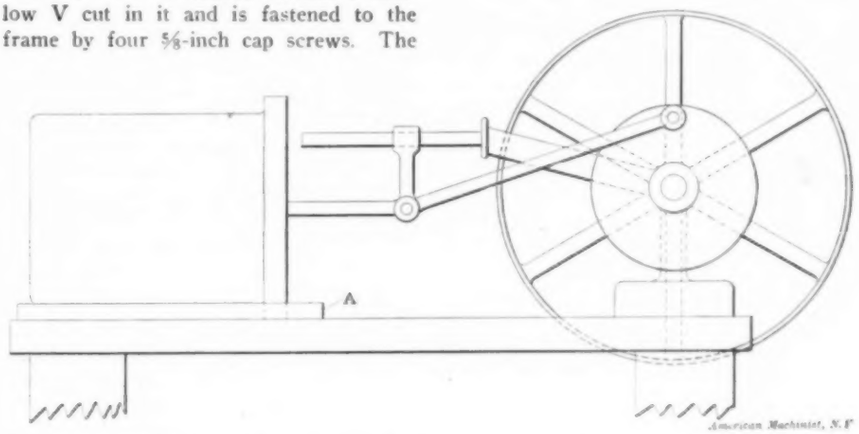
is a bushing made to slide over the screw. *B* is a bar for counterboring the stuffing box.

WILLIAM GLASGOW.

Sherbrooke, Ont.

Grinding in Piston Rings with a Power Hack Saw

The accompanying line cut shows a power hack saw rigged up to be used for grinding in piston rings of gas engines. The pad *A*, which is similar to the one that the vise is attached to, has a shallow V cut in it and is fastened to the frame by four ⅝-inch cap screws. The



POWER HACK SAW AS USED FOR GRINDING PISTON RINGS

cylinders are fastened in various ways, depending on their shape. The rigging can be easily removed and the machine used as a hack saw when desired.

Philadelphia, Penn. A. CALDWELL.

A Cincinnati Scheme for Apprentice Instruction

I have recently suggested the following plan of industrial education: The apprentice is to be sent to school one-half day each week, the employer paying the apprentice for the time he is in school; this course to be continued throughout the term of apprenticeship contract, which in Cincinnati is four years. A committee of manufacturers, consisting of Fred A. Geier, of the Cincinnati Milling Machine Company; William Lodge, of the Lodge & Shipley Machine Tool Company; James Hobart, of the Triumph Electric Company; J. M. Manley, of the National Metal Trades Association; Ernest DuBrul, of Miller, DuBrul & Peters Company, and myself, presented this matter to Superintendent Dyer, of the Cincinnati Public Schools, who looks with great favor on the scheme and will present the matter to the Board of Education with a recommendation to adopt. It will doubtless be accepted, and the school established not later than July 1.

There are about 500 apprentices working in the Cincinnati machine shops. The manufacturers have guaranteed to start the school with 150 apprentices a week, which would make a class of 15 boys each half-day for five days.

The manufacturers feel that the sacrifice which they are making by paying the boys while they are at school will more than be returned by the increased efficiency, and it will also be the means of securing many more apprentices than was possible in the past. We believe that the success of any aprentice system depends on some educational feature of this kind, and it will certainly be of great value to the boy and to the trade generally. The course of instructions will be confined to shop mathematics, shop drawing, and such other particular studies as will be of direct benefit to the apprentice.

Cincinnati, Ohio. B. B. QUILLEN.

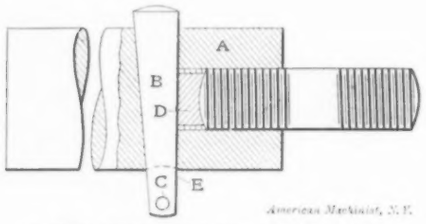
Discussion of the Previous Question

Letters from Our Readers Showing How Many Men of Many Minds Look upon Various Subjects Opened up in Previous Numbers

WE PAY FOR THESE ALSO

Stud Extractor for the Turret Lathe

Upon reading the article by Arthur Cooke page 623, I was reminded of a tool I made many years ago for threading the second end of studs in the turret lathe. For simplicity and quickness it cannot be beaten. The great feature of this rig is that the lathe need never be stopped, and if the studs have been cut off properly with rounded ends at the first operation, the turret need never be turned. In the sketch, *A* represents a piece of machinery-steel bar about 2 inches in diameter, which is held in a collet, bored and tapped to the size of the stud to be handled. The wedge *B* is then fitted, as shown, with pin at *C* to prevent it from falling out when released. *D* is a tool-steel plug, hardened, having one side concaved to suit the end of the stud already threaded. This piece prevents damage to the end of the stud



A STUD CHUCK FOR THE TURRET LATHE

and it should be an easy fit in the threaded hole.

The holder *A* should be flattened at *E*, to prevent the pin in the wedge from falling on sharp corners, causing a bur and stopping the wedge from working freely. The best tool to drive the wedge with, in my opinion, is a stick of round brass about ¾x9 inches long. With the holder in a collet the operator throws in the slow-speed clutch of the lathe to allow him to give a light blow with the brass rod on the large end of the wedge. He then throws in the clutch for quick speed and runs in the threaded end of the stud to be operated on. Change the clutch to speed for threading, thread the stud, then back the saddle far enough to allow the automatic die to clear about 9 inches, and while on the same speed give the wedge a blow on the small end, releasing it and relieving the pressure on the end of the stud. Reverse the direction of the lathe spindle, throw in the clutch for the fast speed, and the stud runs out in your fingers. Reverse the lathe to run forward, throw in the slow-speed clutch, drive home the wedge and you are ready to repeat the operation.

GEORGE SEARLE.

Birmingham, England.

System of Making Changes in Drawings

The very important matter of making changes on drawings was just touched upon by the data on standard practice, page 740, Vol. 31, Part 2. Entropy discussed it on page 109 and Mr. Fiske gave a method on page 489. This latter is in part similar to the plan devised by Harold C. White some four years ago and used by the General Railway Signal Company.

The conditions to meet were these: A wide range of product was made with a total number of parts well up in the thousands. Repair parts were liable to be ordered at any time for apparatus which was continually being improved. Changes could be authorized by three departments: the engineering office, the factory or the drafting room. This required that changes be so recorded that the reason for change, previous condition of the part changed, and person authorizing the change, could be determined at any time.

The general system gave each part a serial number assigned when first drawn up. Fig. 1 shows a typical sheet. The wide (2-inch) column at the right is the "change" column; the narrow (½-inch) column is for the initials of persons ordering the change, and when so appearing guarantees the change is made as ordered. The date inclosed at the head of the column is the date when the drawing was made.

A change order is written on a form letter and reads (omitting dates, titles, etc.):

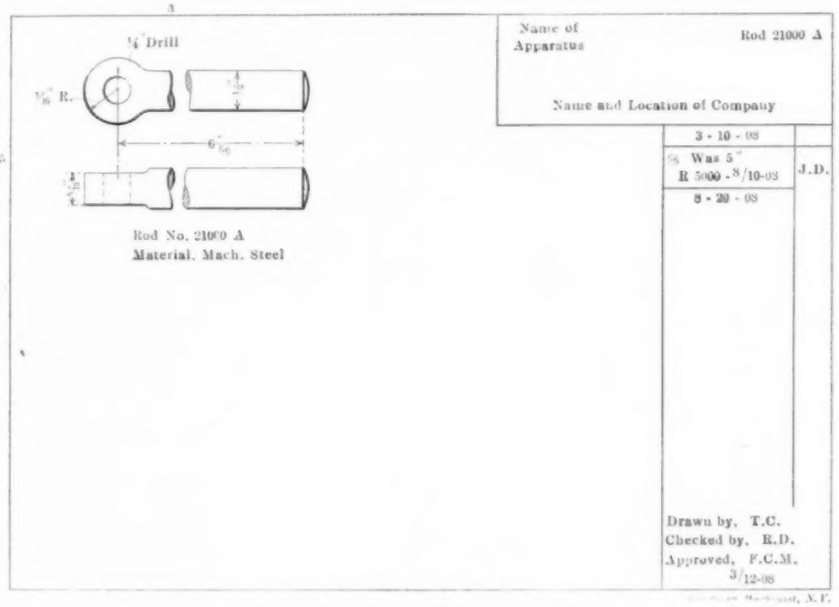
"Chief draftsman:

Please change length of rod 21,000 from 5 to 6 inches.

Reason—Extra length desired by customer.

John Doe, Engineer."

The drafting office investigates the



RECORD OF CHANGES ON A DRAWING

question of this change affecting interchangeability, and then the note is given a reference number, known as an *R* number (in this case will be say 5000) placed thus, *R*-5000, in blue pencil across the face of the note. These numbers are given only by the clerk; he has a list of several hundred in numerical order, and as a number is assigned he draws a line through it; this prevents duplication and is very simple. The note from now on is known by this *R* number. The note is now attached to the tracing and given to the draftsman.

Referring to Fig. 1, the large *A* following the serial number, indicates that the part has been changed from its original form. The next change would be in-

dicated by crossing off *A* and adding *B*. The small *a* indicates the location of the change; by appearing in the margins at points nearest the change the change is readily found, and following this small letter in the change column at right is the data. This is read: "Previous to 8-20-08, dimension *a* was 5;" the change was ordered by *R* note 5000, dated 8-10-08, and tracing changed on 8-20-08. John Doe authorized the change." (This last shown by the initials in the narrow column.)

If a repair part is ordered for apparatus built previous to 8-20-08, the change column tells what to send. If trouble with this part arises on new apparatus the responsibility is fixed at once by the initials. If the original order is required, the file clerk is requested to bring *R*-5000.

The use of this method does not involve any great expense, as a file for the *R* notes is the only extra feature.

Rochester, N. Y. RALPH W. DAVIS.

Should a Machinist Leave His Machine Running While Away From It?

There have been more rows, arguments and ill-feeling caused by this problem than any other shop question. Some machinists seem to shut down their machines at every possible opportunity. I have seen a man shut down his lathe on a long traverse job while the foreman was showing him a blueprint, although he was standing near and the cut had about 20 minutes to run. There seems to be no good reason why machinists, when on long traverse work, should not leave their machines running when they have to go to other parts of the shop; and more than this, why should they not do some bench work, or odd jobs as well? Surely no progressive man cares to stand by a machine while it is traversing or boring on long work, for it is about as uninteresting and monotonous as possible.

Look at the matter from the owner's point of view. He has to meet competition, and if the men have to stand by and wait while the machine does work which requires only 10 minutes of actual attention per hour of machine time, then he either has to pay the men less wages, drive the machines to their utmost limit, which is not conducive to accurate work or economy in machine-tool depreciation and running expense, or he has to work on such a narrow margin that a comparatively small fluctuation in market prices or some unexpected expense will force him to the wall. Of course, we all know the old familiar yarns that are always thrown at the foreman who asks a machinist to do some other work instead of patiently waiting for the machine to get through: "Who's going to to be responsible if the lathe carriage jams into the chuck, or the boring mill or drill press feeds into the feed table, etc.?" Of course, this is a sticker for most foremen, as the machinist well knows, for it means that the foreman either takes charge of watching the machine himself, or lets the man stay where he is, and as the foreman cannot attend to so many details, he generally lets things run along in the old way. But why should not a man be able to do other work and yet give enough attention to the machine to prevent any such "accident" as this? Surely it is not asking too much. A man who is working on "other work" does not frequently forget when quitting time arrives; in fact, he can tell intuitively, generally to within a minute, when the time is up, yet the same man will be unable to tell to within 15 or 30 minutes when a cut is through. Still let it be granted that on many machines there is the chance of a smash-up for even the most careful man is apt to forget once, and once would probably be enough to cause great damage. The cure is obvious; an automatic tripping device can be easily fitted to any lathe or other machine so that it will shut off before anything gets jammed. If a demand arose it would not be long before machine makers would supply automatic adjustable stops to all machines as they now do to milling machines. In the meantime it is unnecessary to wait, but devise some arrangement to fit the machines in the shop. When the machines are safe-guarded in this way there is very little chance of any accident occurring to a properly set tool not running under too great a strain, which would not now be necessary, as the constant expense of operator's time is eliminated. Under these conditions the possibility of the tool "digging in," or the work "slewing" is very remote, and the reduction in cost fully insures the risk.

I do not wish it to be understood that I am taking the owners' side in this argument; I simply uphold what seems to be the right and progressive view, and I have seen both methods tried. In one case it was a frequent occurrence to see machine hands sitting beside their machines dreaming while the machine was running on heavy work, stirring themselves only about every half hour to see that everything was O. K. and occasionally to sharpen the tools. In the other case every man was alert and always doing something profitable, such as running one or two machines and doing bench work as well. Now which system is most likely to produce the best and most intelligent men?

Exeter, N. H. GEORGE P. PEARCE.

W. L. McL., in his article under the above title, on page 748, has opened a subject for discussion that will without doubt be of interest to many of us; and I, for one, hope to derive some satisfaction from the outcome of it. In the meantime I wish to present my views.

There is without doubt instances where an operator can with safety leave his machine in operation during his temporary absence; also instances where it is imperative that he either do so or not leave the machine at all. On the other hand, there are times when it is unsafe to leave a machine running without attendance, even though it might perform its work in a satisfactory manner. For example, in the latter case, suppose a man has just set up a large piece of work on a planer; I think that he should not leave the planer in operation during his absence on the roughing cut, because he has no proof that his work is clamped firmly enough to withstand the pressure of the cut, or that the cut will not become too deep for safety, or that there are no hard spots to cause the tool to lose its cutting edge, and possibly other reasons, but the ones mentioned are the most important and sufficient. After he has a roughing cut without any mishaps he can safely leave the machine on a second cut because if the work could become loose, or if the tool slide could pull down, etc., it would have happened on the roughing cut. In fact, taking a roughing cut over the work safely proves that the next cut will pass over safely, and although the nature of the job mentioned is such that it is not necessary to keep the machine running, I think a man would be justified in doing so. Again, suppose a machinist is boring a large cylinder; every good mechanic knows that if the machine is stopped on the finish cut and allowed to stand, a difference in the diameter at this point can be easily measured. Hence, to do a good job, it is necessary that the machine be kept in continuous operation on such a cut. Ofttimes this requires considerable time, perhaps four or five hours, and is a man to be expected to be in constant attendance all that time? I think not; in fact, it may be impossible for him to do so.

I believe that a man who is careful and able to exercise good judgment can safely leave his machine to take care of itself during a short absence. By being careful I mean that he should see that his machine is well oiled, that there are no obstructions to the travel of the lathe carriage, if it be a lathe, such as tools, etc., carelessly left on the ways; that parts that should be secure and remain so are secure, and parts that should work freely do work freely, etc. By exercising good judgment I mean being able to determine whether the nature of the work is such that a machine will safely perform it without his attendance, or if the risk is too great to allow it to do so.

I have seen work pulled loose, gears stripped, centers sweated fast and broken off, machines broken, and work spoiled by leaving a machine to take care of itself, and the operators called down or discharged; in fact, I have not been exempt myself. But I never saw an instance of this kind that could not have been prevented had the proper precautions been taken.

Albany, N. Y. T. COVEY.

Effective Organization of Assembling Department

Mr. Spangenberg in his article on page 510 expresses the wish that "some discussion will be forthcoming on this subject." This is an accomplished fact in one shop:

A "dour" Scotchman, who has charge of the inspection and assembly department, having read Mr. Spangenberg's article, saw at once the enormous amount of time he was losing, and has informed the machine-shop foreman that all jigs and fixtures are to be handed over to him, and maybe he'll take the machine shop after a bit if it will save time in the assembling.

This puts the poor machine-shop man (an inoffensive Englishman) between the Devil and the deep sea. As the tool-room foreman comes along with the remark: "Every divil of a wan of thim jigs comes back to me, or I'll hev your blood, so I will. I've towld you once, twice before, so I did, thet I checks every wan of them. It's at the bottom of the Irish sea yer'd be saving toime if I hed my way, damned aliens thet yer are; every wan of ye." Meanwhile the storeman has put in for the assembling department and a rise at the same time as he knows the firm will not put his store with its 13,000 different castings, not to mention other items, in the assembling department, and it would mean years of time saved if he got hold of the said assembling. And now the chief is studying the "War of the Worlds," armed to the teeth, and it means a violent death for the man brave enough to ask the question, what is assembling?

Belfast, Ireland. TERRY.

Annealing Iron Castings

Mr. McLaren's article, on page 800, about annealing iron castings, with black oxide of manganese, gives information that will be valuable to many and I am glad to know how he does it. By the way, however, of offering something to others, from whom I have received much, through your columns, I wish to call attention to a method that is applicable to castings which have become hard by coming in contact with water while redhot. It is simply "water annealing;" taking care to observe the heat in a dark place, to be sure that redness is just disappearing and then dipping in a tub of hot water, the hotter the better.

I have seen gear blanks of cast iron, 15 to 20 pounds in weight, treated successfully in this way and the gears stood up all right when put to work. I know that some high authorities on steel claim that water annealing cannot be done with any degree of certainty, but I must dissent from this view, having practiced it more or less ever since I was an apprentice, over 25 years ago, and of the hundreds of pieces treated I am unable to recall a failure.

The successful use of the water anneal seems to be dependent on thorough, even heating, a dark place for observation, a keen eye for red heat and hot water for dipping. In observing the cooling metal, the eye should be rested frequently by closing it, so as to keep it sensitive to the dull reds, or otherwise the tendency will be to dip at too high a heat and this will result in a harsh gritty metal.

Allentown, Penn. I. P. M.

A Jig for Milling Thread Rolling Dies

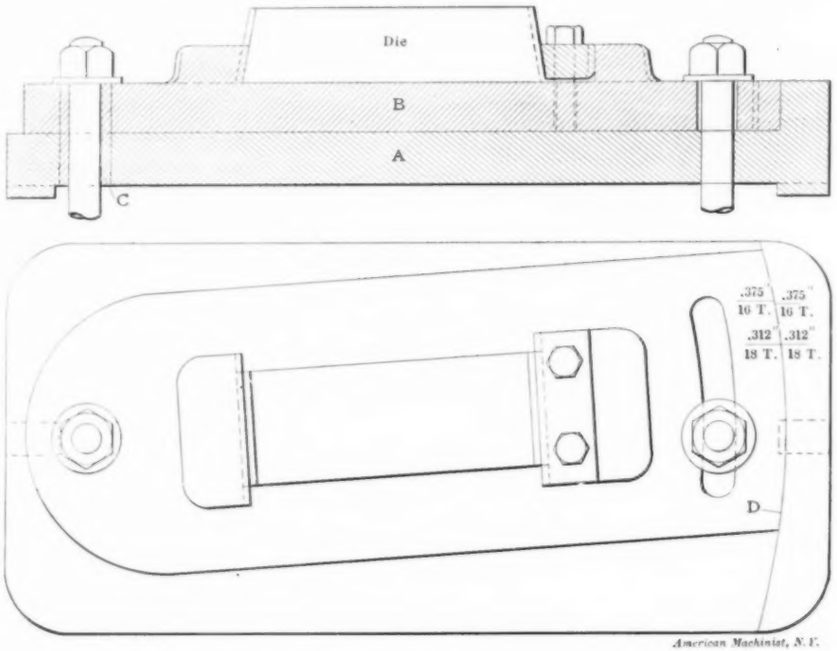
On page 403 there appears an article on "Thread Rolling Dies," in which the writer gives a method of determining the angle at which the dies are to be milled to roll a given thread.

He gives the angle in degrees and minutes. Very few milling machines are graduated to minutes, also very few have verniers. It would seem that a better method would be to give the angle as incline per foot. The E. J. Manville Company recommends this method in its catalog. It is easily understood, and by its use the average toolmaker can get accurate results with a minimum amount of trouble.

Having had to produce thread-rolling dies in a shop where there was no universal, I had to design a jig to do the work on a small, plain milling machine.

Reference to the cut of the jig shows that it consisted of two principal parts, the lower one of which is marked *A* and the upper one *B*. The two parts were machined top and bottom. *A* has two lugs on its under side to fit the platen of the machine.

It has also a part on its upper right-hand end, which was turned on its inside at the same time the pivot hole was bored. A bushing was forced in the pivot hole, as shown at *C*. This acted as a pivot for the part *B*, which had its other end turned to an arc to fit the arc *D* in part *A*. At this end it was also provided with a slot to pass the holding-down bolt *E* and also to allow movement around the bushing *C*. On its upper surface were two lugs and a gib, to hold the die in position. Referring to Manville's catalog it will be seen that the "incline per foot" for certain screws is only slightly different; for instance, we find that for a screw 0.375 inch 16 threads, the incline per foot is given as 0.72 inch and for 0.437 inch 14 threads, the incline per foot is given as 0.71 inch. This led to the marking of the jig in the manner shown, as being at once simple and effective, and avoiding confusion. The die itself is shown in position in the jig ready for the milling operation.



A JIG FOR MILLING THREAD-ROLLING DIES

Birmingham, England. WULFRUNA.

Another Belt Drive

The ingenious arrangement of a belt drive, shown on page 751, by Mr. Anthony, has suggested another which uses one less pulley and avoids cutting the joist. The large drive pulley being 50 inches and the driven 16 inches, it requires less than one-third the larger circumference to secure equal belt contact.

Lynn, Mass. A. A. BALL, JR.

English versus American High Speed Steels

By E. T. Clarage*

I have read, with much interest, the many articles you have published on the subject of tool steel from time to time, and from the standpoint of a tool-steel maker, wish to compliment you on your good judgment in publishing articles which possess real merit. There is so much unreliable matter presented to the publishers of trade journals nowadays that it requires some discrimination as to what is correct and suitable for publication and what is not.

On page 728 of the present volume you published an article that originally appeared in *The Engineer*, published in London, England. The tests reported might look very wonderful to an office man or anyone not familiar with American shop practice. As a matter of fact, to one who knows what is being done with a number of first-class American high-speed steels this report means nothing at all and is not anywhere near up to the amount of work being done daily in our first-class shops.

The best test reported on cast iron was a run of two minutes at 60 feet per minute, reduction of diameter ⅜ inch, that is 3/16 inch on a side, with 1/16 feed. This was the best tool in the entire lot and only lasted two minutes; removing 3½ pounds of chips.

In contrast to this we can give you an authentic report of a test made with a standard American high-speed steel running on cast iron from 130 to 140 feet per minute, with a cut 5/16 inch deep, and ⅛ to ¼ feed. This tool stood up all day without grinding and removed chips at the rate of 1000 pounds per hour. The English tool fell down at 60 feet a minute after two minutes' run, and removed chips at the rate of only 105 pounds per hour. I saw a tool made from Columbia, an American high-speed steel, the other day which had run from 9 o'clock in the morning until 5 o'clock in the afternoon on cast iron, taking a big cut at the rate of 85 feet per minute.

Some of the representatives of the English steel makers are claiming that they have new steels which will do ten times the work of the standard high-speed steels. In order to do this in comparison with the last tool mentioned, they would either have to run all day at the rate of 850 cutting feet per minute or else they would have to run at least ten days without grinding at 85 feet per minute. These claims are manifestly ridiculous. We give the English steel makers credit for their efforts to improve the cutting qualities of their steel, but not anywhere near in such proportions as claimed by them. As a matter of fact, the American tool-steel manufacturers are constantly improving their steels without, however, changing the name, advancing the price or claiming the credit of any wonderful new discoveries.

As an indication of the lines along which the American tool-steel manufacturers are working, the following explanation in regard to the hardening of carbon steels and also the hardening of high-speed steels will be of interest.

The microscope shows us a number of different structures, four of which are of the most importance to the steel maker. Ferrite, as its name indicates, means iron, and is free from carbon and simply holds the hardening carbon in solution. Cementite, which is found to be Fe_3C is a chemical compound of iron and carbon in the proportion of 14 parts by weight of iron to 1 part by weight of carbon. This cementite forms in crystals which are imbedded or suspended in the surrounding ferrite.

All chemical changes are accompanied by heat. Some few elements will combine chemically at ordinary temperature, very often with such powerful reaction that an explosion results. Most of the elements, however, will combine only at high temperatures. This is the case with carbon and iron. When the temperature of the piece of steel is raised above the point of recalescence averaging about 1370 degrees Fahrenheit the carbon which has existed as Fe_3C changes to a new chemical compound or $Fe_{24}C$. This compound is known as martensite which is the hardest condition of carbon known in steel. This you will note, is a compound of iron and carbon in the proportion of 112 to 1. Why 112 parts iron to 1 part carbon is harder than 14 parts of iron to 1 part carbon, I do not know. It may be possible that this mass of iron surrounding the carbon exerts sufficient contraction to crystallize the carbon.

Most steel workers are under the impression that sudden cooling is what hardens tool steel. As a matter of fact cooling of itself does not produce the hardness. If a piece of steel is heated to the point where martensite forms and allowed to cool slowly, the carbon will change back to the cementite condition, whereas if the piece of steel is suddenly cooled in water, the carbon has not time to effect this chemical change and is, therefore, retained as $Fe_{24}C$ or martensite carbon. Although it takes nearly 1400 degrees to form this interesting chemical combination, it by no means requires this amount of heat to break it up. Unfortunately this is not a stable compound. At 400 Fahrenheit this $Fe_{24}C$ begins to change back to Fe_3C. At about 700 degrees the change has been completed and the steel is no longer hard.

There is another compound of iron and carbon recognized as austenite. This cannot be formed at a temperature lower than 1800 Fahrenheit. When this high temperature is reached, the carbon assumes the austenitic condition, but with a straight carbon steel it is impossible to cool the piece fast enough to retain very much of the carbon in this condition and then only when carbon is excessively high.

We now come to the exceedingly interesting explanation of the modern high-speed steels. In the presence of tungsten, chromium and other alloys, the rate of change for this carbide is greatly lengthened. In other words, as Mr. Taylor has aptly expressed it, the carbon gets tangled up with the alloys and its solution in iron changes very slowly. The complete change can readily be made by giving it sufficient time as proved by the fact that all of these high-speed alloy steels can be beautifully annealed if cooled sufficiently slow.

In the presence of these alloys, it is possible to retain practically all of the carbon up to the saturation point in the austenitic condition. The chemical formula of this austenite carbon has not yet been determined, but inasmuch as the saturation point for high-speed steel seems to be in the neighborhood of 0.60 per cent. carbon, it is probably an even higher proportion of iron combined chemically with the carbon than shown in the martensite condition. This austenite carbon unfortunately is not so hard as the martensite, but it has the remarkable property of being a much more stable compound under the application of heat. In the presence of these alloys, it is possible to heat the steel as high as 1200 Fahrenheit without effecting a change back to the soft or cementite condition. It is due to this property that the high-speed steels are so effective.

A high carbon tool steel left full hard will show 100 hard under the scleroscope while none of the high-speed steels show much over 80 hard.

A recent test at various temperatures showed the following results on a piece of high-speed steel ⅜ inch square. At ordinary temperature the piece showed 86 hard; heated to a dark straw, it showed 79 hard; heated to a dark blue, it still showed 79 hard; and heated to a dull red the piece showed 75 hard. The rule is that the tool should be at least three times the hardness of the metal it is cutting. An ordinary machinery steel shows 16 to 18 hard. This piece of steel at a red heat was over four times its hardness and therefore would cut machinery steel at a red heat and hold its edge continuously.

The American tool steel makers understand these conditions perfectly and have been intelligently striving to improve their high-speed steels so as to bring about the greatest possible amount of red hardness. It is well known that by increasing the amount of these high-priced alloys, a more lasting tool can be produced, but

*President of Columbia Tool Steel Company, Chicago Heights, Ill.

this increases the cost greatly and the ductility of the steel is so impaired that it is difficult to roll it or hammer it into required shapes without producing too large a proportion of seamy bars.

The American tool-steel manufacturers, therefore, have not only made an effort to better the quality of their steel, but have endeavored to keep the cost within reasonable limits, at the same time producing a steel that is sufficiently ductile to stand working. As a matter of fact very few users realize the capacity of half a dozen different American high-speed steels. When it comes down to actual performance and effort is made to get all that is possible out of the tools, it will be found that a number of American high-speed steels on the market will do fully as much work as these much flaunted English tool steels.

It may be possible that we will be able to produce a high-speed steel in which the carbon will be in the martensite, that is the hardest condition, and yet so stable that it can be brought to a good red heat without changing back to the cementite carbon, or we may be able to produce double carbides, but that is another story. The American tool-steel manufacturers as a rule are not groping about blindly in the dark, but are working along scientific lines with a definite object in view and have made wonderful strides even recently in the production of high-speed steels.

Trade Opportunities in Argentina

By M. de Moreira

In spite of all the great opportunities for the export of machinery to the Republic of Argentina, in spite of all the improvements which are going on there constantly and which are a source of wealth to the manufacturers of various countries, in spite of the internal financial crisis which happened in this country in 1907 and which should demonstrate the great value of having an established export trade, in spite of all this the American manufacturers have not availed themselves of their opportunities, and the result is that the exports from the United States to Argentina show a decrease of $12,887,947. It seems strange that products manufactured in this country and most in demand there now, are just those which, in the machinery and transportation lines, show a decrease.

The figures given by *La Direccion General de Estadistica* are eloquent. For instance agricultural machinery shows a decrease of $2,502,858; iron and steel and manufactures thereof, a decrease of $124,365; locomotives, etc., a decrease of $9,709,148.

To what can we ascribe this decrease? Not to the financial state of that country, since its finances are in very good condition, as is demonstrated by the state of the national debt, which has been reduced upward of $20,000,000 gold, and by the gold reserve in the treasury, which amounts to $125,000,000, securing the paper currency in circulation; not to the lack of opportunities, since other countries have a good export trade with Argentina. To what then? To the manufacturers who do not avail themselves of their opportunities. Manufacturers seeking export trade may be divided into three distinct classes: Those, a very few in comparison, who know the country, its wants, how to advertise their goods, and how to reach the natives and who, in return, export machinery in good quantity; those who, knowing nothing of the country and but little of export trade, do not trust the people there and think that their products are such that it is absolutely necessary to send a man with every machine to explain its working, confident as they are, that these people are not sufficientiy educated; and lastly the manufacturers who seek export trade today and drop it tomorrow, as they have received no returns or because the conditions at home have changed, who, on account of their lack of constancy, do not do any exporting and who think opportunities are too few, when, on the contrary, they are very numerous.

Of all the South American republics, Argentina, without doubt, possesses the largest railroad system. Last year it boasted of 12,000 miles of railway, this year this stretch of road has reached 13,746 miles. These roads are owned by 22 companies, who operate 11,908 and by the government, which possesses 1838 miles of track. The net gain of these railroads during the past year was more than $33,000,000, showing an uptodate condition of things which ought to encourage our manufacturers of machinery, tools and railroad appliances in seeking such a market.

Besides this the Ferro Carril Norte Argentino is constructing a line from Rosas to Casta Sacate and the Central Argentino is constructing three new lines and a branch from Rio Tercero to the Andine railway and the company del Ferro Carril Buenos Ayres y Rozario has obtained concessions to build two small lines, the work of which is to begin soon. The Southern railway is building nine branches and extensions aggregating 826 miles, bringing thus, the railway to the Chilean frontier in the Cordillera. Locomotives, tenders, rolling stock, machinery tools and in general, machinery of all kinds for railroad work and repair shops are most needed.

Besides this, Buenos Ayres has 378 miles of street railways which are divided among seven companies employing 1655 cars in service. These street railways are electrified and the cars are entirely modern in their equipment, some having fans, electric heaters, etc. Extensions and ramifications of these roads are under construction, offering again opportunities for manufacturers of other lines of machinery. Manufacturers of dredges and excavating machinery and those in general who manufacture any kind of machinery necessary for the construction of a subway, think of the opportunities now open in the construction of an underground railway in Buenos Ayres, which, is now planned to run from the center of the city to the port.

The government of Argentina has authorized the expenditure of $47,000,000 gold for the enlargement of the port of Buenos Ayres and the construction of a deep water canal from Buenos Ayres to the Porosa river. It will also spend $30,000,000 in the construction of a port for transoceanic vessels at the mouth of Quequen Grande river and $1,000,000 for hydraulic and dredging work in the Gualeguaychu river.

Mining in Argentina, though not on as large a scale as in Brazil and Chile, offers, nevertheless, fairly good opportunities. The mines are located on the Rioja province some 10,000 feet above the sea level and have had railroad transportation and facilities for the past ten years. One company develops copper-silver lodes, another lead ores of smelting character and the others produce high-grade copper matte. Except one company, which has a very improved plant, the others, though doing a good business, certainly need modern mining machinery.

Textile machinery has also a field in Argentina, although more restricted than in Brazil, where 1,000,000 spindles and 30,000 looms are in operation. Still Argentina is a good field for manufacturers of such machinery, especially now, since the cultivation of various kinds of fiber-producing plants is increasing more and more.

All these opportunities, to which can be added others for the sale of building materials, which are now mostly imported from England, Germany and France, form a large field for our manufacturers to increase their business and, knowing, as I do, both countries, the resources here, in uptodate machinery and the need there for that machinery should lead to important connections between the American manufacturer and the Argentinian buyer.

The figures showing the production of gold and silver for the past year will not be forthcoming for many months according to the *Scientific American*, the amount of production for 1907 having just been calculated. In that year the gold output amounted to $90,435,700, and silver for the same period was 56,514,700 fine ounces—$37,299,700. The total production of the precious metals of the whole world for 1907 is placed at $410,555,300 in gold, and 185,014,623 fine ounces in silver—$122,090,000. The consumption of gold and silver in the industrial arts in the United States amounted to $40,727,070 and $24,360,784, respectively.

Homogeneity of Formulas

By Antonio Llano

The principle of the homogeneity of formulas is but an application of the self-evident fact that quantities of different kinds can be neither added nor subtracted. We cannot, for example, add three horses and six miles, nor an area and a length, nor seconds and foot-pounds.

Before stating the principle, a few preliminary definitions and explanations are necessary.

In the first place, a distinction must be made between concrete numbers and abstract numbers. A *concrete number* is a number that represents, or relates to, a special kind of quantity. An *abstract number* is a number that has no reference to any special kind of quantity. The important feature of this difference consists in this: concrete numbers depend upon the units used, whereas abstract numbers are independent of the units used. If, for instance, x represents the length of a line, and $\frac{1}{2}\ x$ the length of half the line, the number x is a concrete number, since its value depends on the unit of length used in measuring the line. The number $\frac{1}{2}$, on the contrary, as used here, is an abstract number, for it remains unaltered whatever the unit of length may be.

The quotient obtained by dividing a concrete number by another concrete number expressing units of the same kind is a constant abstract number. Thus, the ratio of a length of 36 feet to a length of 12 feet is the abstract number 3. If the lengths are expressed in inches, the two numbers become, respectively, 36×12 and 12×12, the ratio of which is $(36 \times 12) \div (12 \times 12)$, or 3, as before.

When a concrete number is multiplied or divided by an abstract number, the result is a concrete number of the same kind as the number multiplied or divided.

The quantities to which the concrete numbers occurring in engineering problems relate are of two kinds; namely, fundamental quantities and derived quantities.

A *fundamental quantity* is a quantity that usually is, or can be, measured directly by means of a unit, called a *fundamental unit*, independent of quantities of other kinds. The fundamental quantities are length, time and force.

A *derived quantity* is a quantity that differs in kind from a fundamental quantity, but whose numerical value is, or may be, expressed in terms of fundamental units combined in a special manner. Thus, any area may be expressed as the product of two numbers representing the lengths of two lines; or, as we say for shortness, as the product of two lengths: any velocity $\left(v = \frac{s}{t}\right)$ may be expressed as the quotient obtained by dividing a distance (length) by a time: any acceleration $\left(a = \frac{v}{t} = \frac{t\,s}{t^2}\right)$ may be expressed as the quotient obtained by dividing a velocity by a time, or a distance by the square of a time.

The units used in a formula are said to be *consistent* with one another when all the concrete numbers entering the formula are referred to the same fundamental units. If, for instance, the fundamental units are the *foot*, the *second* and the *pound*, and all units in a formula are to be made consistent with one another, it is necessary to express all forces in *pounds*, all distances in *feet*, all velocities in *feet* per *second*, all work in *foot-pounds*, all volumes in cubic *feet*, etc.

In what follows, certain capital letters will be used to denote fundamental quantities of certain kinds, and certain combinations of these letters will be used to express the manner in which derived quantities depend on fundamental units. These letters and combinations will be called *qualitative symbols*. We shall use L, T and F to denote length, time and force, respectively. These symbols, be it understood, are mere abbreviations for the words *length*, *time*, *force*, and do not represent numbers.

Since area may be represented by the product of two lengths, its qualitative symbol is $L \times L$, or, for shortness, L^2. Likewise, velocity, which may be expressed as the quotient of a distance (length) by a time, has the qualitative symbol $\frac{L}{T}$.

Although the symbols L, T, F do not represent numbers, they may be combined by multiplication and division according to the rules of exponents, in order to indicate how derived quantities are obtained from fundamental quantities. Thus, since the symbol for velocity is $\frac{L}{T}$, and acceleration is obtained by dividing velocity by time, the qualitative symbol of acceleration is

$$\frac{L}{T} \div T, \text{ or } \frac{L}{T^2}.$$

The general rule for finding the qualitative symbol of a derived quantity is this: Write the general formula by which the quantity is mathematically defined, and then, disregarding abstract numbers, replace the letters representing concrete numbers by their qualitative symbols.

As an illustration, let us find the qualitative symbol of kinetic energy. We start by writing the general expression for kinetic energy, which is $\frac{W v}{2 g}$, and then proceed as follows, disregarding the abstract number 2, and using the notation $|Q|$ to mean *qualitative symbol of*:

$$|Q|\ W\ (\text{force}) = F.$$

$$|Q|\ v^2 = \left(\frac{L}{T}\right)^2 = \frac{L^2}{T^2}.$$

$$|Q|\ g\left(= \frac{v}{t}\right) = \frac{L}{T} \div T = \frac{L}{T^2}.$$

The qualitative symbol of kinetic energy is, therefore,

$$\frac{F \times \frac{L^2}{T^2}}{\frac{L}{T^2}} = F\,L.$$

This result could have been obtained directly by considering that energy is a quantity of the same kind as work, and that, since work is measured by the product of a force and a distance, its qualitative symbol is obviously $F\,L$.

Likewise, intensity of stress, or unit stress, which is stress (force) per unit of area, may be represented by $\frac{S}{A}$, where S is stress and A area. The qualitative symbol is, therefore, $\frac{F}{L^2}$. Power, being work per unit of time, may be represented by $\frac{U}{t}$, where U is work and t is time. The qualitative symbol of power is, then, $\frac{F\,L}{T}$.

It is obvious that quantities of the same kind have the same qualitative symbols; and that, conversely, quantities having different qualitative symbols are of different kinds.

We shall say that a formula is *regular* when it is independent of the units used, provided those units are consistent with one another. When a formula does not satisfy this condition, we shall say that it is *irregular*. Take, as an example, the formula for the velocity v of a body falling freely through a distance h; namely,

$$v = \sqrt{2\,g\,h}.$$

This is a regular formula, for it applies to all units, provided they are consistent. If, now, we adopt the foot and the second as units, and write 32.16 for g, the formula becomes $v = 8.02\ \sqrt{h}$. This formula is irregular, since it applies only for the special units assumed.

It will be seen from the foregoing that one of the distinguishing features of a regular formula is that every concrete number entering such formula is represented by a letter having no definite or special value.

A *homogeneous formula*, or *homogeneous equation*, is an equation in which all the terms reduce to the same kind when each letter representing a concrete number is replaced by its corresponding qualitative symbol.

We may now state the *principle of the homogeneity of formulas*, which is as follows:

Every regular formula is homogeneous; and, conversely, every homogeneous formula is regular.

The first part of this principle follows

from the fact that in a regular formula the kind of every term can be determined by replacing every concrete number in that term by a qualitative symbol; and, in order that the formula may have a meaning, all terms must be of the same kind, or have the same qualitative symbol. Take, for example, the equation of work

$$f\,s = R\,s + \frac{W\,v^2}{2\,g},$$

in which f is a force acting through a space s on a body of weight W and against a resistance R. It is assumed that the body starts from rest, and that at the end of the space s it has the velocity v. This is a regular formula, for it applies whatever the units used may be, provided only that they are consistent. Such being the case, it is obvious that $f\,s$, $R\,s$ and $\frac{W\,v^2}{2\,g}$ must be quantities of the same kind, as otherwise they could not be equated, added nor subtracted. We have seen that this is really the case, since the qualitative symbol of work ($f\,s$ and $R\,s$) is the same as that of kinetic energy $\left(\frac{W\,v^2}{2\,g}\right)$—namely, $F\,L$.

The second part of the principle of homogeneity will be better understood by an illustration. We shall take again the equation

$$f\,s = R\,s + \frac{W\,v^2}{2\,g}, \qquad (a)$$

but now our assumption will be not that the formula is regular, but that it is homogeneous; and we are to show that, if it is homogeneous, it is regular. Suppose this formula to be true when the units are the foot, the pound and the second. Let s_1, f_1, R_1 and g_1 represent the same quantities when the units are, respectively, the yard, the ton and the minute. Then,

$$s = \frac{s_1}{3}, \quad f = \frac{f_1}{2000},$$

and, therefore,

$$f\,s = \frac{f_1\,s_1}{6000}.$$

Since $R\,s$ and $\frac{W\,v^2}{2\,g}$ are of the same kind as $f\,s$ (for the formula is assumed to be homogeneous) we may write at once

$$R\,s = \frac{R_1\,s_1}{6000}, \quad \frac{W\,v^2}{2\,g} = \frac{\frac{W_1\,v_1^2}{2\,g_1}}{6000}.$$

Substituting these values in formula (a), we get, after canceling the common factor $\frac{1}{6000}$,

$$f_1\,s_1 = R_1\,s_1 + \frac{W_1\,v_1^2}{2\,g},$$

which has the same form as equation (a), and shows, therefore, that equation (a) is independent of the units used, or that equation (a) is regular.

The principle of homogeneity has two very important and very useful applications: (1) to the checking of formulas; (2) to the transformation of formulas from one system of units into another.

(1) When a general formula is derived without making any assumption as to the units used, the formula must be homogeneous; and if it is not, that fact will at once show that a mistake has been made. It does not follow, however, that the formula is necessarily right if it is homogeneous; the principle of homogeneity shows simply whether the formula is possible or not. Let us take the following formula as an example, it being supposed that no assumptions have been made regarding the units:

$$A\,h = \tfrac{1}{2}\sqrt{\frac{(h^4 + r^4)\,(h^4 - r^4)}{3\,(h^2 + r^2)\,\sin P}}.$$

Here A is an area, and h and r are lengths or distances. Neglecting the abstract factors $\frac{1}{2}$, 3 and $\sin P$, and remembering that the sum or difference of two quantities of the same kind may be represented by one symbol, we have

$$|Q|\ A\,h = L^2 \times L = L^3,$$

$$|Q|\sqrt{\frac{(h^4 + r^4)\,(h^4 - r^4)}{h^2 + r^2}} =$$

$$\sqrt{\frac{(L^4 + L^4)\,(L^4 - L^4)}{L^2 + L^2}} =$$

$$\sqrt{\frac{L^4 \times L^4}{L^2}} = \sqrt{L^6} = L^3.$$

Therefore, the formula, being homogeneous, is possible.

In the appendix to Thurso's "Modern Turbine Practice" is reprinted a paper read by a prominent engineer before the American Institute of Electrical Engineers. The writer gives the following general (regular) formula for the energy E of a rotating wheel of weight W, the angular velocity in radius per second being a, and the radius of gyration of the wheel J:

$$E = \frac{a^2\,W\,J^2}{2}.$$

Now, the qualitative symbol of E is $F\,L$, as we have already seen. Since $a = \frac{v}{r}$, (denoting by v the linear velocity of a point distant r from the center), we have

$$|Q|\ a = \frac{\frac{L}{T}}{L} = \frac{1}{T}\ ; \quad |Q|\ a^2 = \frac{1}{T^2}.$$

The qualitative symbols of W and J^2 are, respectively, F and L^2. Therefore, the qualitative symbol of the second member of the formula is

$$\frac{1}{T^2} \times F \times L^2 = \frac{F\,L^2}{T^2}.$$

As this symbol is different from that of E, the formula, being impossible, is wrong. The fact is that the author defines the moment of inertia as the product $W\,J^2$ instead of $\frac{W\,J^2}{g}$. If the divisor g (acceleration of gravity) is introduced in the second member of the formula, the formula becomes homogeneous, as the reader can easily verify.

(2) When it is desired to change a formula from one system of units into another, the formula is first examined for homogeneity. If the formula is homogeneous, it applies to all units, and no change whatever is necessary. Under such circumstances, all factors not representing specified concrete quantities are abstract numbers. Take, for instance, the velocity of water flowing from a nozzle,

$$v = c\sqrt{2\,g\,h}.$$

Here

$$|Q|\ v = \frac{L}{T}, \quad |Q|\sqrt{2\,g\,h} =$$

$$\sqrt{\frac{L}{T^2} \times L} = \frac{L}{T}.$$

As the formula is homogeneous with respect to v, g and h, it is a regular formula, the factor c (the coefficient of velocity) being an abstract number. The formula is, therefore, applicable to all units, although the coefficient c varies with the character of the nozzle.

If the formula is not homogeneous, it is irregular, and all or some of the numbers it contains must be changed when the units are changed. In this case, a convenient rule to use is this: *Find the qualitative symbol of the first member of the formula, and then transform those terms, and those only, whose qualitative symbols are different from the qualitative symbol of the first member.* The method of procedure will be illustrated by an example.

Using the meter and the second as units, Weisbach gives the following formula for determining the head h necessary to give a velocity v to water flowing in a pipe of length l and diameter d (here g denotes, as usual, the acceleration of gravity):

$$h = \left(0.0144 + \frac{0.00947}{\sqrt{v}}\right)\frac{l\,v^2}{2\,d\,g}$$

The qualitative symbol of h is L. The qualitative symbol of $\frac{l\,v^2}{2\,d\,g}$ is also L, as can be easily verified

Since $\frac{l\,v^2}{2\,d\,g}$ is of the same kind as h, the quantity in parentheses must be an abstract number. The number 0.0144, which stands by itself, needs no transformation to make it abstract. In order to make the fraction $\frac{0.00947}{\sqrt{v}}$ represent an abstract number, we must introduce in the numerator a quantity of the same kind as $\sqrt{v}$.

Let a velocity of 1 meter per second be denoted by v_1. Then, we may write

$$\frac{0.00947}{\sqrt{v}} = \frac{0.00947\sqrt{v_1}}{\sqrt{v}}.$$

By the substitution of this value, the formula becomes regular in form, it being understood that v_1 is a velocity of 1 meter per second expressed in terms of the units used, such as feet per second or yards per minute. If we wish to transform the formula to the foot-second system, we have, since 1 meter = 3.281 feet,

$$v_1 = 3.281 \text{ feet per second}$$

$$0.00947\sqrt{v_1} = 0.00947\sqrt{3.281} = 0.0172.$$

Therefore, for the foot and second as units, the formula becomes

$$h = \left(0.0144 + \frac{0.0172}{\sqrt{v}}\right)\frac{l v^2}{2 d g}.$$

The principle of homogeneity is often useful for deriving a formula the general form of which is known; or, we may say, for remembering the exponents in a formula. Suppose we know that the centrifugal force C of a rotating body is equal to the mass of the body multiplied by the ratio of some power of the velocity to some power of the radius, but that we do not remember the exponents. Let us write

$$C = \frac{m\, v^x}{r^y}.$$

The qualitative symbol of C is F; therefore, the qualitative symbol of $\frac{m\, v^x}{r^y}$ must also be F. Since $m = \frac{W}{g}$, we have,

$$[Q]\ \frac{m\, v^x}{r^y} = \frac{F}{\frac{L}{T^2}} \times \frac{\left(\frac{L}{T}\right)^x}{L^y} =$$

$$F\, L^{x-y-1}\, T^{2-x}.$$

This symbol must reduce to F, which is the symbol of the first member. Therefore, the exponents of L and T must each be zero, and so we must have

$$x - 2 = 0,\ x - y - 1 = 0;$$

whence $x = 2$, $y = 1$. The formula for centrifugal force is, therefore,

$$C = \frac{m\, v^2}{r}.$$

Those who have fears as to the relegation of the horse by automobiles will find assurances in the figures published in the last report of the Department of Agriculture in which it is noted that the number of horses in the United States increased from 13,537,000 in 1900 to 19,992,000 in 1908, their total value having increased from $603,000,000 to $1,867,000,000, which might be surprising to some in face of the great strides of the automobile industry.

A Geared Head That Puzzled the Inventor

By R. E. Marks

Jim Fasset was a young chap who started in to learn the trade a few years ago but perhaps was not what you might call a born mechanic. But he drifted into the shop and I supposed he was still there until I ran across him the other day shoveling stuffing for a pie foundry. After I had expressed surprise at his change of occupation he told me of his troubles about as follows; omitting sundry remarks which would singe any but asbestos paper and trimming the picturesqueness of his language a little at the high spots. For Jim can spill language in a way that would do credit to a preacher or a book agent.

"Oh, I liked the machine business all right and was getting on fine until one of these salesmen hoodooed the old man into buying an all geared machine. I ain't knocking nobody so will call it a corn twister. Well, that sure put me to the bad.

"That agent could monkey those levers with his eyes shut and put the gears through their paces to beat the cars, but no one else could after he went away. There were seven levers scattered around kinder promiscous like, not a name or number on a single lever and index plates that a Philadelphia lawyer couldn't dig any information out of with a search warrant. Between lever in and lever out, back gears and open belt, caution plates about not feeding in and out at the same time, I got plumb dotty about the second day. Talk about saving the time of shifting belts—gee I could shift every belt in the shop while I was trying to make up my mind which lever to pull—and then 'twas usually the wrong one.

"Course I know I ain't no college chap and that I never was worth a cent on puzzles of any kind, but there wasn't a man in the shop who breathed easy while he tried to run it. So the boss gave it to me, because he rather fire me than any of the others if they bust it. I tried playing sick and laying off but 'twas no use and it got on my nerves.

"Well, one day the head guy of the firm that built it came round with the salesman and the boss told them a few good wholesome truths about the animal and it didn't set well on his digestion.

"So, with several unkind and somewhat forcible remarks, directed mainly at the dod-ratted descendant of a jackass, meaning me, the chief tester with the bulgy bosom, waltzes over to the machine and proceeds to show the boss and incidentally me, how anybody who wasn't all fool, could handle it.

"The first few passes worked out all right and his stock went skyward while mine shivered around zero, when all of a sudden, with an oh, so easy look on his physog he slapped in the wrong lever and there was things doing, to onc't and sudden.

"I've never had the luck to hit an earthquake yet but the harmonious chords of those gear teeth involuting and epicycloiding around in that gear box would have made a Chinese musician green with envy. And the way he spouted language, blaming it all on me, mind you, would have melted the wax off any phonograph on earth.

"So I quit the job as being too complicated for me when the designer himself can't work the combination on his own machine. I can do a good many stunts in the shop but that gets me going every time.

"And one of the fellows over in the shop where they built the thing tells me the old man doesn't dare touch a single machine there now, but gets someone else to show them off."

After I left Jim and his pie job I took pains to see how much of the story had been due to his fertile brain, but strange to say (for I've known Jim some time) it was verified practically as he told it.

Now this isn't a knock at gear boxes as much as at complicated machinery of any kind that is difficult to handle and liable to damage. Some geared machines are very simple, the index plates showing clearly just what to do in every case and also showing at a glance what feeds and speeds are being used. Others, on the other hand, are far from simple to the average machinist and do not show him where he is at without considerable figuring of one kind or another. Of course, a man can get used to anything but the education is sometimes expensive.

An Improved Pin Punch

By S. A. McDonald

In assembling small machines it is often necessary to have a variety of pin punches. The usual one-piece punch bends or breaks and has to be scrapped.

The accompanying cut shows a simple pin punch which can be made in different

A PIN PUNCH

sizes to suit. Both ends of the punch holder are hardened while the punch itself is made from long pieces of tempered drill rod. When a punch breaks or bends the workman grinds off another piece of the rod to replace the broken one. A drop of oil in the holder is sufficient to hold the punch in place, and by heating the holder the oil boils and forces the punch out. Punches of this sort are stiffer and better than those turned from solid tool steel.

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The Training of Apprentices

The question of proper and thorough training for workmen, or for boys who wish to become good mechanics is still uppermost in the minds of many if we can judge by the time given to its discussion by the National Metal Trades Association at its recent meeting. This discussion included the work of the Winona Institute, which is not only indorsed by, but is also a recipient of funds from this association; the half-time or Schneider plan as being worked out in Cincinnati, Fitchburg, and a few other places, and also the industrial or shop-training plan, as mentioned by Mr. Bullard.

There is no gainsaying the fact that such an institution as that at Winona can do efficient teaching and do much toward fitting boys to become good mechanics. The same can be said of Professor Sweet's work in Syracuse and a few other instances. But in most cases of this kind the work is necessarily limited and in some of the places at least, the boy must be supported by others the same as if he were at any other kind of a school. And we cannot get away from the idea, advanced by Mr. Bullard, that the good mechanic, no matter what his position, must learn of shop work by being in actual contact with it. As stated by Mr. Newcomb, of the Deane Steam Pump Company, the best boys they get (and they come from the Williamson School, near Philadelphia) lack the touch of accuracy which is so essential in commercial work and which cannot apparently be taught outside of the actual commercial shop.

There is no question but that a boy makes a better mechanic if he has a working knowledge of the foundation principles of his business, such as the mathematics necessary to handle any problem that comes up in the shop, but not necessarily touching algebra proper and stopping far short of any approach to the calculus, and if he has not had this in school it is better for him to acquire it as soon as possible. In fact, even if he has had it in school its application has usually been so vague, the problems being in rods of stone wall, or the fox eating chickens, that it means very little to him in the shop.

Few shops are large enough to warrant the establishment of schools, but almost any community can arrange such a plan as suggested by Mr. Bullard and worked out in Bridgeport, or the half-time school plan which has worked so successfully in Fitchburg. This has the enthusiastic support of all the shops in the town with which we are acquainted, and the managers do not hesitate to say that the boys who come from the school and only work half time, learn fully as fast as those who are in the shop every day and every week.

Back of the question of teaching the boys, however, is the problem of getting them and holding them until they have become skilled in the face of inducements from other shops who do not train boys at all and who announce, as though it were a cardinal virtue instead of a grievous fault, that they are not in business for their health, and it is cheaper to let the other fellow train the boys. Assuming this to be true, it is a short-sighted policy, and one which can hardly be commended by anyone who is broad minded in his vision. But we have pretty good evidence to prove that apprentices do pay and that where they do not, it is a sign of poor management in the way they are handled. Nor is this justifiable because of the low wages paid for the shops which are most enthusiastic in advocating apprenticeships, pay double, or even more, the rate that was thought all sufficient 10 to 20 years ago.

The old rate of 50 cents per day effectually prevents any but the boy living at home from learning the trade and cuts out the boy who most needs it and is often the most worthy. The boy who leaves school as soon as the law allows must earn enough to support him even if it drives him into the ranks of unskilled labor with no hope of ever getting out of it. Realizing this, the progressive shops are paying from $1 to $1.25 per day at the start, and in some cases raising this to $2.25 per day for the fourth year. Others have no fixed rate beyond the first year, but frequently pay from $1.75 to $2 per day to apprentices who have proved their worth.

Aside from the question of holding a boy by contract it is pretty certain that he will take more interest in his work and become a better workman, if he is not shut out from all the enjoyments of boys of age. Of course, self-denial is a great training, but it is an open question as to the effect on the general character of the boy who has to squeeze every penny and who never has the broadening influence of an occasional theater or social gathering. The standards of living are very different from that of 20 years ago, and though it is difficult for us to realize it, perhaps, it has its effect on mechanics as well as other classes.

The great success of such institutions as the Franklin Union, of Boston, mentioned on account of its rapid spring into popularity as soon as opened, shows the desire for education among those who are working at the trades and who realize the advantage of adding to their knowledge. Men who work in an engine room all day come to study engines, even to taking them apart and putting them together. And this because they are learning while they are at work earning their living, or even supporting a family.

For this same reason it seems to us that the half-time high school, or the part-time school conducted by a coöperation of the various employers, or even by a city, will be much more effective on acount of being possible in more places than such schools

as the Winona Institute, or any similar institutions. This is not doubting their excellence or usefulness, although if it came to choosing between such institutions and the simpler plans of Cincinnati, Fitchburg or Bridgeport, we believe the latter will accomplish the most good per dollar expended. A large institution requires large amounts of money and constant watchfulness as to expenditure and income, and while the latter is also true of the smaller school, it can be handled by even very small groups of manufacturers, and can be put into practice while the preliminary plans are being drawn for the more elaborate institution.

We doubt if it pays to ask the boy to go to school at night even if some of us older men did get our start in that way. A couple of hours a day away from the shop, with pay, will be the best-paying two hours the boy can put in for the firm if he learns nothing more than that he has the opportunity of becoming more than an ordinary workman. Nor should he be left to himself in the shop, as a little careful instruction may save many dollars in the repair account each year.

Coal Weights

A manufacturing concern recently adopted a method of checking its coal weights and found that it was receiving considerably less coal than it was charged for, one barge load being some sixty tons short. The management refused to pay for more than was received, and the coal company brought suit to recover the full amount of its bills. Testimony was offered to the effect that it was the general custom to accept "railroad weights" in billing and settling for coal delivered, after which the attorney for the coal company announced: "Your Honor, the plaintiff rests his case;" whereupon the court immediately responded: "The plaintiff has no case."

Not a word of testimony had been offered to show that the amount delivered agreed with that for which bills had been presented, and if the current practice is anything like that which the attorney for the coal company tried to establish, it will be well for others to put some kind of a check upon their coal receipts.

The Longest Pipe-line

Pipe-line connections have been completed by which it is possible to pipe oil from the Oklahoma wells to New York harbor. Oil has been started on the long journey of 1500 miles. This is the longest pipe-line in existence in the United States, and indeed in the world. It is not probable that much oil from the Mid-continent district will be brought to the seaboard at present, and the completion of the line seems to be more in the nature of a provision for the future, or for emergencies which may arise. Oklahoma has the most active oilfield in the country at present; moreover its production is increasing, while that of Pennsylvania and West Virginia is decreasing. It may not be long before the western wells will be called upon to supply the seaboard and export demand.

New Publications

INTERNAL COMBUSTION ENGINES. By Wm. H. Hogle. 256 5½x8½-inch pages with 106 illustrations. The McGraw Publishing Company, New York. Price $3.80.

The internal combustion engine supplies a field for a great variety of books ranging from the ultra scientific to the strictly practical, the book under notice being of the latter class. It begins in strictly orthodox manner with a history of the engine and a description of the various cycles under which they are operated, after which come descriptions of some of the leading engines, in at least a historical sense; and a comparison of the cycles. Following this is a chapter on practical operation, including troubles and remedies, and next comes a series of chapters on carbureters, vaporizers and injectors, producers, fuels and combustion, compression and the indicator card, and finally on the dimensions of the leading parts, these last being discussed quite fully with the aid of simple formulas. The book closes with a series of tables, all of which may be found in any good pocket book and for which there is hence little excuse here.

The chapters on the dimensions of parts will be found of real use by the designer while the remaining chapters, though containing nothing that has not been said many times, will, no doubt, supply information to beginners in the study of the gas engine.

THE CALCULATION OF CHANGE WHEELS FOR SCREW CUTTING ON LATHES. By D de Vries. Spon & Chamberlain, New York. Cloth, 83 5¼x8½ pages. 46 illustrations. Price, $1.50.

This book is intended for the use of machinists, apprentices and students and aims to set forth in practical manner the principles and methods involved in gearing up lathes for cutting screw threads. The author takes up separately and in detail the cutting of English threads on lathes with English lead screw; English threads with metric lead screw; metric threads on lathes with metric lead screw, and metric threads with English lead screw. A commendable feature of this part of the book is the liberal number of examples given under each of the above cases. Simple and compound trains are, of course, explained as is also the cutting of multiple-thread screws and coarse-pitch threads generally. Diagrams are included showing different forms of threads with tables of standard thread parts; and thread tools and means of setting them are discussed. A number of engravings are included showing English and American lathe-gear systems. A section on approximate fractions which is prepared for the benefit of those having occasionally to calculate gears for odd threads, is open to criticism. About 20 pages are devoted to this subject and the general treatment is such that the average reader will, we believe, pass the chapter by without attempting to follow it in detail. Aside from this, however, the book should prove a useful treatise to any lathe operator having screw threads to cut.

Personals*

W. S. Rogers—the only Rogers—returned recently from a five weeks trip through Germany.

C. C. Wais, of Cincinnati, has lately made a business connection with the Covington Machine Company, Covington, Virginia, which has secured the control of his patents on punches, shears, and elliptical boring and turning machinery.

Hugo Bilgram, of Philadelphia, Penn., who has recently had his business incorporated under the name of the Bilgram Machine Works, sailed for Germany on June 15, via the North German Lloyd line. Mr. Bilgram intends to pay a visit this summer to his old home in Germany—the first in forty years.

John Bomler, for several years mechanical inspector at the Franklin works of the Chicago Pneumatic Tool Company, has accepted a position as machine foreman, in charge of the machine department, of the Jacobson Machine Manufacturing Company, builders of gas and gasolene engines, Warren, Penn.

R. Leyrit, after many years of experience in French automobile factories of the highest class, has decided to cast his fortunes with the American automobile industry and will sail for this country in the near future. He was for three and a half years superintendent of the De Dion-Bouton factory, three years with the Clement works and for the three years just past with the Société Lorraine De Dietrich, for which firm he planned and installed their magnificant new works at Argenteuil which many Americans have visited.

The first electric smelting plant in the world in which pig iron will be produced on a commercial scale is about to be installed in Norway, according to the *Scientific American*. The plant will be fitted with an initial installation of two 2500-horsepower reducing furnaces for iron ore and two 600-horsepower steel furnaces.

*Items for this column are solicited

New Tools and Machine Shop Appliances

Showing New Ideas in Machine Shop Equipment That Make it Possible To Do Better Work at a Reduced Cost

THE LATEST INFORMATION

A Plain Geared Drive Milling Machine

The pulley on the driving shaft is 16 inches diameter by 5 inches face. It runs free on the shaft which has a disk keyed to it. An expanding-ring friction clutch is fitted between the pulley and the disk. The control of this clutch is through the medium of the lowest lever on the side of the housing of the machine shown in Fig. 1. This enables the machine to be stopped and started at will by the manipulation of this lever which is within easy reach of the operator. With this arrangement the machine can be belted direct from the line shaft. Sliding on the driving shaft is the regular Hendey type of rocker with driving and transfer gears, which are engaged at will with any one of the five gears in the gear cone on the spindle.

The rocker is controlled by the lever extending from the diagonal guiding slot, provided with notches and locking-pin holes, shown in the center of the housing in Fig. 1. The gear cone runs free on the spindle, being engaged with it by a positive toothed clutch controlled by the middle lever in Fig. 1. By means of this clutch the spindle can be stopped or started with the driving shaft in motion.

Double back gears are provided in this machine which run permanently in mesh with gears on the spindle. A positive toothed clutch similar to that referred to on the machine spindle operates between the low and high back-gear combination.

The clutches and engaging members are made of hardened crucible steel. With the arrangement described 15 spindle speeds are obtainable.

The upper lever in Fig. 1 operates the back-gear clutches. Ring oilers are provided on all shaft bearings. The feed drive is by chain direct from the driving shaft and 21 changes of feed are obtainable by means of a gear box similar in design to that in the Hendey-Norton lathe.

The table has a working surface 16x60 inches, a longitudinal power feed of 42 inches, cross-feed by power of 12 inches and a vertical automatic feed of 20 inches, all of which are provided with automatic trips. Ball thrusts are provided on the elevating and table feed screws.

Fig. 2 shows the double back gears with the cover removed. This milling machine, known as their No. 4, is built by the Hendey Machine Company, Torrington, Conn.

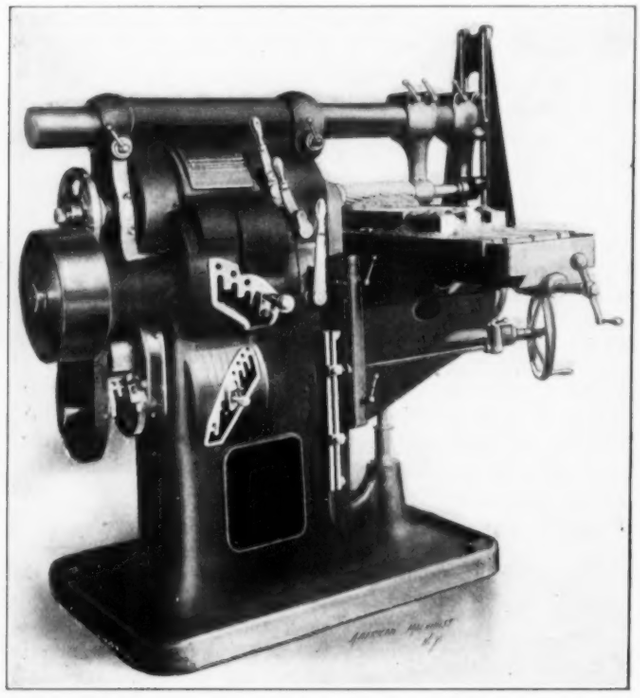


FIG. 1. A PLAIN GEARED DRIVE MILLING MACHINE

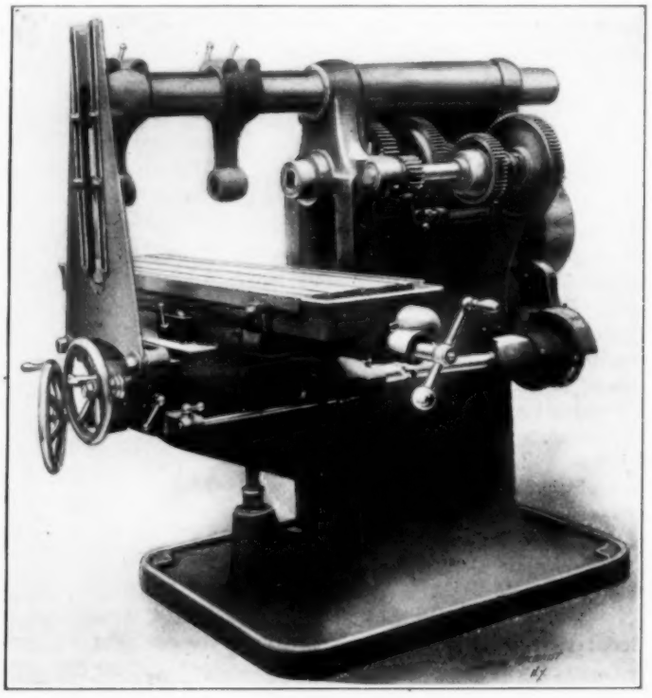


FIG. 2. DOUBLE BACK GEARS WITH COVER REMOVED

Multiple Starters for Large Direct Current Motors

Starting devices are required for all direct-current motors except in the smallest sizes, in order to limit the current which would flow through the motor when first connected to the circuit. With small motors, face-plate rheostats are used extensively and give a high degree of satisfaction, but for large motors it is impracticable to build a satisfactory face-plate rheostat which will be free from sparking under the large current handled. Furthermore, large motors are capable of producing far more damage when handled by careless operators than small motors are, and it is, therefore, particularly advisable to have starting devices which are proof against careless and ignorant operators.

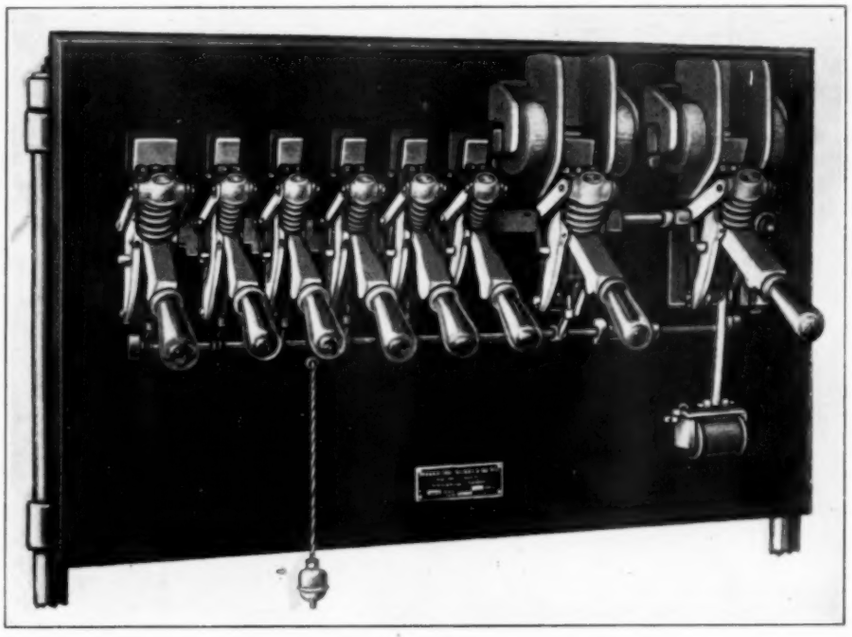
For such reasons as suggested above the Westinghouse Electric and Manufacturing Company has constructed a line of multiple switch starters for motors from 50 to 600 horsepower. The general appearance of a double-pole starter for low-voltage circuits is given in the illustration. The motor is started by closing the switches, one at a time, in regular consecutive order from right to left. In

the double-pole type shown the closing of the first switch connects one side of the motor circuit to the line, closing the second establishes the shunt-field circuit and the armature circuit, the latter through the entire field-starting resistance. Each succeeding switch short-circuits a section of resistance, and the last one also provides a permanent circuit for no voltage and overload release coils.

It is impossible to close the switches except in the proper order, as they are interlocked. The switch on the extreme right, facing the board, must be closed first, and each switch when closed permits the closing of only the one next on the left, and cannot be started and thrown across the line in a shorter time than is required to close all of the switches one by one. To limit the current to full-load value one minute should be allowed for starting. If started in half this time the current will be 50 per cent. greater.

As an additional protection in starting, the low-voltage release device which operates the first switch is not connected permanently to the line until the last switch is closed, and the first switch will remain closed only while the no-voltage release magnet is excited. If current is cut off from this coil for any reason the switch will open and release all the others. Therefore in order to be able to keep the switches closed while starting, an auxiliary circuit for the no-voltage release magnet is closed by pressing a push button until the entire starting resistance is short-circuited. This insures against an operator inadvertently leaving part of the switches open.

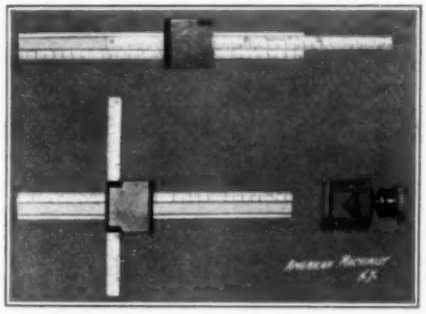
On the double-pole starters, the first two switches are single-pole circuit breakers, but on the single-pole starters the first switch only is a circuit breaker. Powerful blowout coils are provided on these breakers to prevent injurious arcing when the circuit is opened. The overload release opens the circuit of the low-voltage release magnet, and since this magnet must be excited while starting, as well as while running, the motor is protected from overloads at all times.



MULTIPLE STARTERS FOR DIRECT-CURRENT MOTORS

Combination Depth and Gage Square

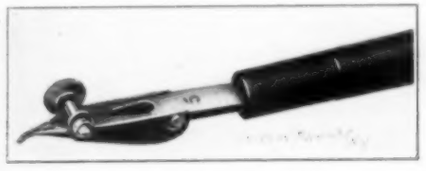
This tool consists of a graduated body in which a narrow scale is fitted and a clamp by which the scale may be secured either in the longitudinal groove in the body or at right angles thereto. In the rear face of the tool there is a V-groove which receives a clamping shoe operated by a nurled thumb screw as illustrated in the end view. The shoe is counterbored to receive a spring and the end of the thumb screw is turned down to form a shoulder which presses against the spring while the point of the screw contacts directly with the shoe. The patentee of this tool is Wm. J. Gillard, 3617 Chicago avenue, Minneapolis, Minn.



COMBINATION DEPTH GAGE AND SQUARE

Payzant Block Lettering Pen

The pen shown in the accompanying halftone is intended for block lettering, and for making border and other heavy lines. The marking point of the pen is so formed as to produce the same width of line, no matter in what direction the pen is moved over the paper. The reservoir attachment gives the pen capacity for a large number of words with each filling. As the pen gives at once the full width of line desired, it is obvious that it saves the time and trouble required where lines have to be filled in with a fine pen. The pen is made in six sizes for as many widths of lines by Keuffel & Esser Company, Hoboken, N. J.



PAYZANT BLOCK LETTERING PEN

A ½ Socket Wrench

The halftone shows a new socket wrench which has recently been put on the market by the Frank Mossberg Company, Attleboro, Mass. It is a handy tool for automobiles, motor-boats, gas engines, and other light machinery.

As will be seen, the handle is similar to a vise handle and when not in use can be folded down to lie flat against the body of the wrench while the enlarged ends prevent it sliding out of the hole in the body and becoming lost.

This arrangement requires little space in the tool kit. Twenty-seven sizes of regular hexagonal sockets from 5/16 to 1 9/32 inches, and one size special hexagon socket 29/32 inch to 4 inches long, for spark plugs, besides three square sockets

A SOCKET WRENCH

are made to fit the body of the wrench. These sockets are furnished singly or in any combination of sizes.

A Planer which Accelerates Its Speed in the Cut

Those who have taken the trouble to figure out the net gain due to a high return speed for planers, realize that it is usually much less than is commonly supposed and that a slight gain in the actual cutting speed is of more value than a much greater increase of the return. One of the important features which limit the increase of cutting speed in planer work is actually conceded to be the shock of the work against the tool at the beginning of the cut, and to obviate this, while at the same time securing a high cutting speed, this planer has been designed so that the tool enters the cut at a low or normal speed of, say, 40 feet per minute, and, as soon as the tool is fairly in the cut the table is accelerated to 120 feet per minute, which is maintained until the tool is about ready to leave the cut. The table then slows down to the lower speed, the tool leaves the cut and the table reverses at the normal speed, but is returned at the high rate. Numerous tests have been made and the tool seems to stand up perfectly at a cutting speed of 120 feet per minute in open-hearth steel, which seems to bear out the theory of the damage to tools being occasioned by the shock of entering at high speed.

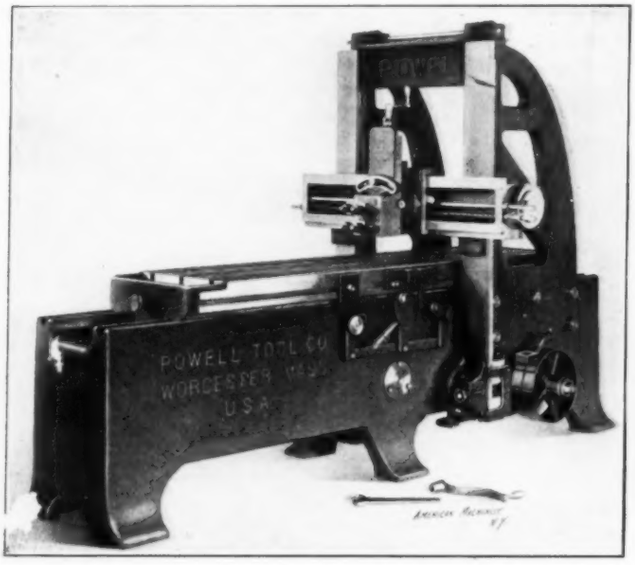


FIG. 1. PLANER WHICH ACCELERATES THE TOOL ON THE CUT

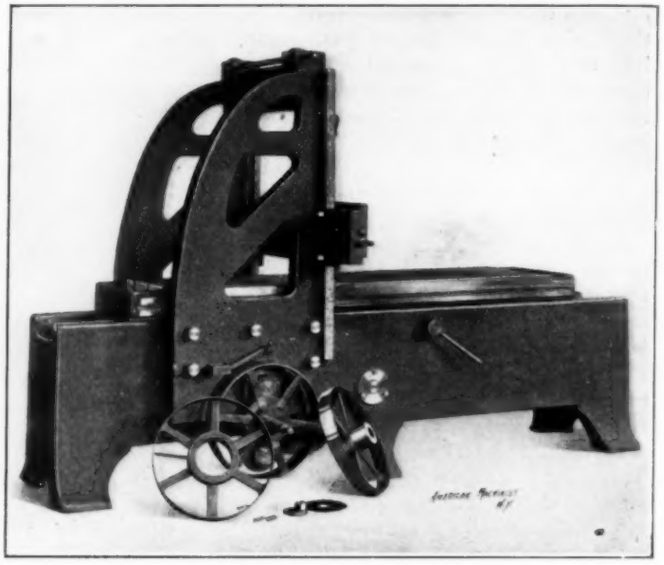


FIG. 2. THE ACCELERATING MECHANISM

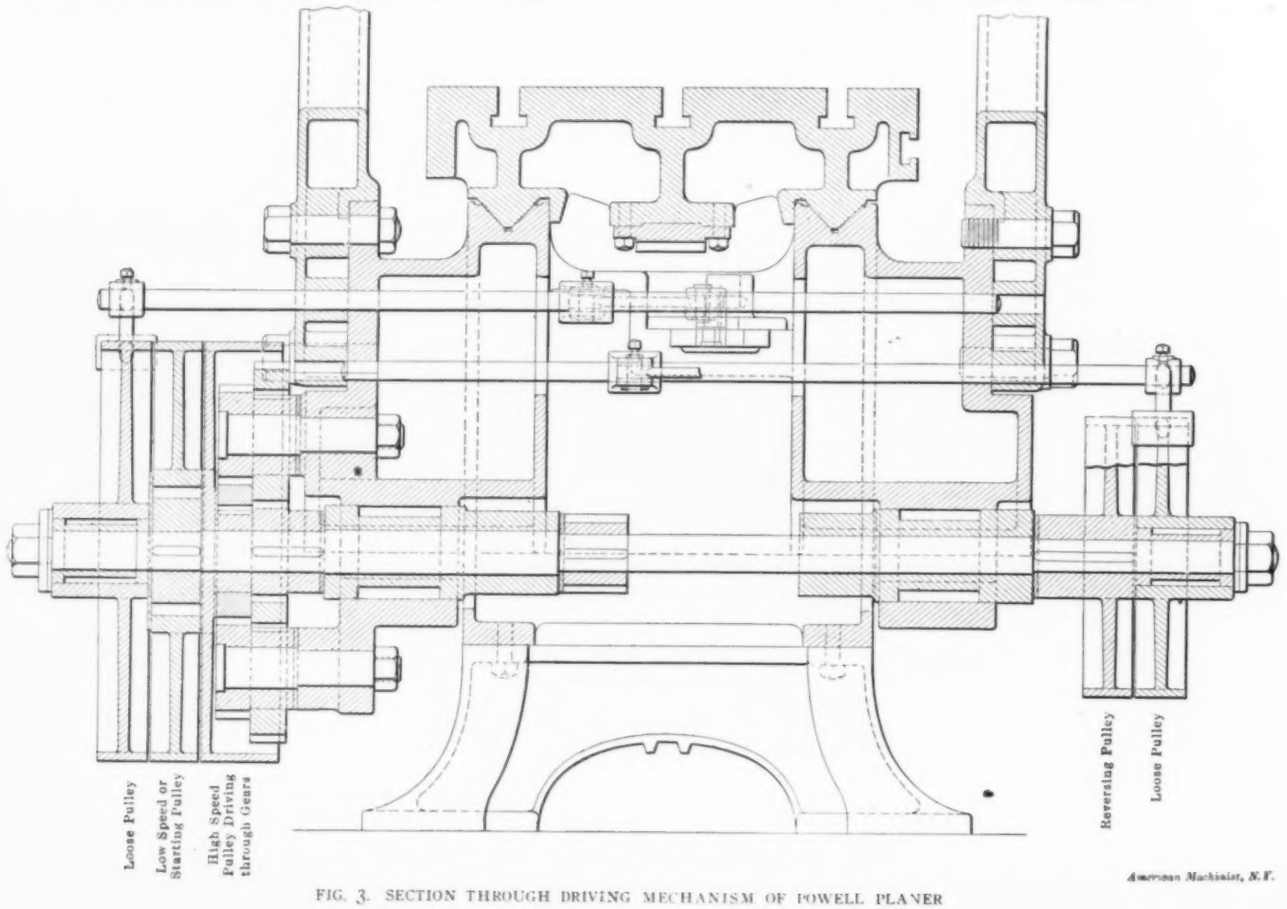


FIG. 3. SECTION THROUGH DRIVING MECHANISM OF POWELL PLANER

This is accomplished with very little mechanism, the additional reversing dog shown on the table in Fig. 1 and the extra pulley and gears shown in Fig. 2 being all that is required. The planer starts into the cut in the usual way and as soon as it is fairly entered the accelerating dog throws the driving belt on the high-speed pulley, which is shown in place next to the bed in Fig. 2. While this pulley runs at the same speed as the others it transmits a motion to the shaft which drives the table that is three times its normal speed by the use of the differential gear train, shown on the inside. This pulley has an extension hub with three inclined recesses for the clutch rollers shown on the floor, and the pulley with the large bore goes over this hub. Outside of this is the usual loose pulley shown at the right. As the planer reverses the belt is shifted from the outside or loose pulley to the one with the clutch in the hub and this starts the planer table into the cut at the normal speed. From here the belt is shifted onto the inside pulley and the clutch pulley remains idle, the shaft running away from it, until the end of the cut. Further details of this can be seen in Fig. 3. The speed ratio can be made to suit, but the 3 to 1 seemed to work very nicely in this case.

There are a number of other interesting features about this machine, one of them being the feeding mechanism shown in Fig. 1. This consists of a friction driven from the intermediate shaft and transmitting an intermittent motion to the vertical rack through a crank pin, which is adjustable in the horizontal slot shown. This allows very fine adjustment and by moving it back of the center a feed is obtained in the opposite direction. The inside of the bed next to the V's is planed and the table is also planed in a corresponding manner so that, while these surfaces do not form a bearing or come in contact, it may be called a safeguard against any side movement of the table under the thrust of a cut, which might tend to lift it up on the V's. This planer is being built by the Powell Tool Company, Worcester, Mass.

Hot Swaging of Tool Steel Spindles

Cold swaging has established its position in the manufacturing field and many interesting examples have been shown in these columns from time to time. But there is a limit to the work that can be done in this way and the Langelier Manufacturing Company, Providence, R. I., has developed a hot-swaging machine that is doing good work in the making of tool-steel spindles for use in textile machinery.

The machines resemble those used for cold swaging, as can be seen in Figs. 1 and 2, the dies being inclosed and the work held in the pneumatic chuck, which is shown more in detail in Fig. 3. The rear view, Fig. 2, shows the inlet and outlet for the air and the valve above which controls its admission to the cylinder.

The air cylinder at the top *A*, carries a piston which connects to lever *B*, pivoted below and bearing against the hardened blocks *C C* in the yoke which controls the movement of the split chuck holding the work. Air admitted into the cylinder forces piston *A* to the right, tightens the chuck on the work and holds it until the work has been forced into the dies to the required distance when it strikes a stop. Then the carriage is drawn back, the work still gripped in the chuck, until the tripping roll beneath engages the valve lever, shuts off the air and the work is released. A new piece is inserted against the stop pin, the chuck closes as soon as the carriage is moved toward the dies and the operation is repeated.

How quickly this can be done is shown by Figs. 4 and 5, which show the sizes of

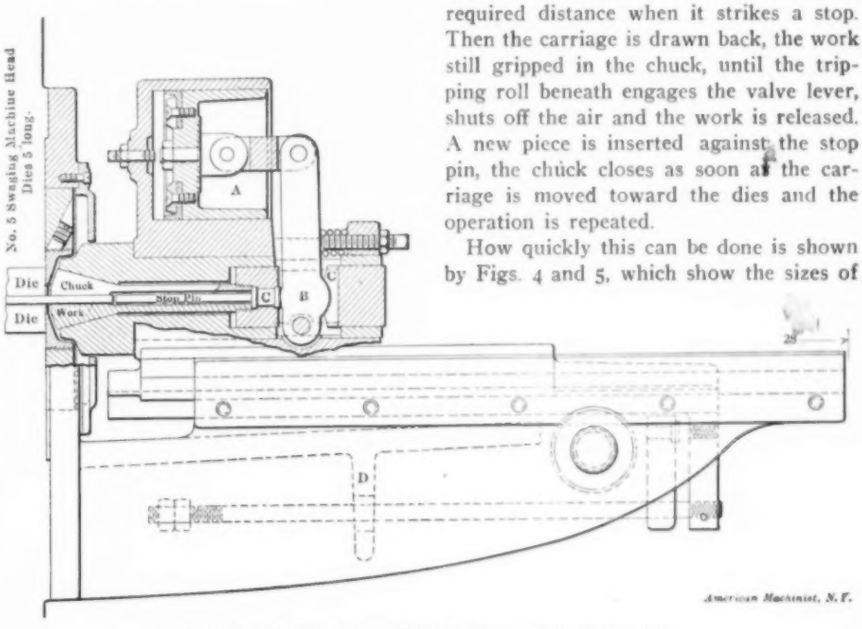


FIG. 3. PNEUMATIC HOLDER FOR HOT SAW MACHINE

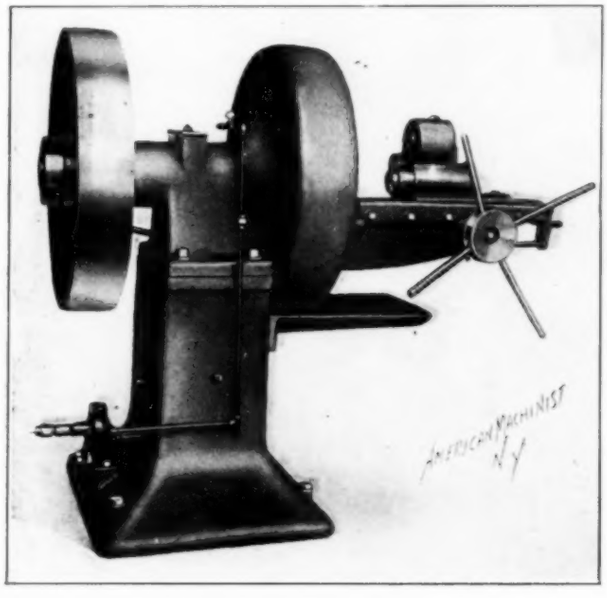


FIG. 1. HOT SWAGING MACHINE

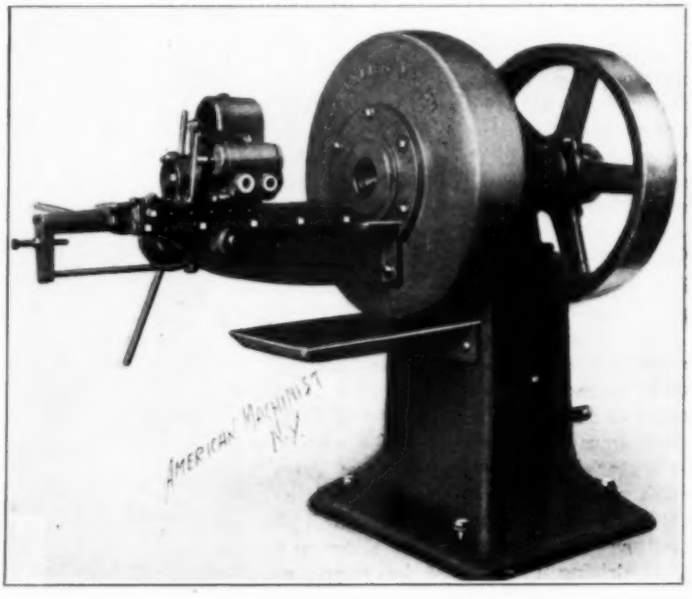


FIG. 2. REAR VIEW SHOWING AIR-OPERATED CHUCKS

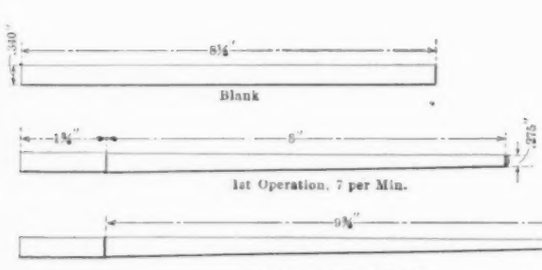


FIG. 4

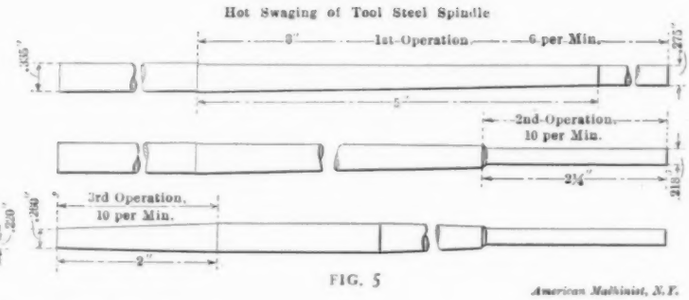


FIG. 5

American Machinist, N.Y.

TOOL STEEL SPINDLES THAT ARE HOT SWAGED

the tool-steel spindles, the reduction that was made by swaging and the rapidity of the whole operation. In Fig. 5, the first operation was done on the special No. 5 machine as shown, but the second and third operations were performed by the regular 3½-inch machine with dies 3 inches long. A forked centering guide was attached to the front face of the machine for steadying the spindles while being swaged. An air jet is used to blow the scale forward by the hot swaging out of the dies and working parts of the machine. A rotary pump, shown in Fig. 1, lubricates all the working parts and is returned to the base through a strainer.

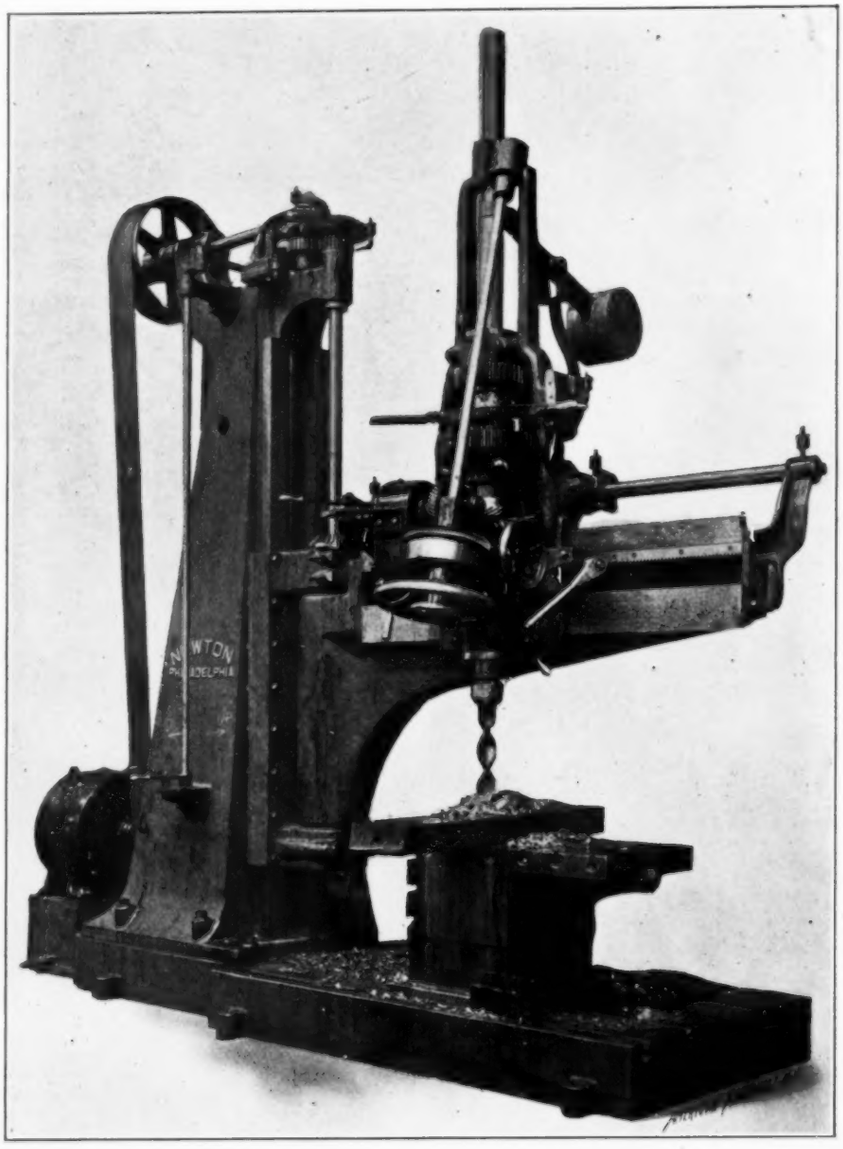
These examples will probably call to mind other pieces where the swaging process can save time and money and if the stock is too hard or the reduction too great for cold swaging, the hot process, as indicated here, may be made available.

Six Foot Radial Drilling Machine

The accompanying illustration shows a new heavy-duty radial drilling machine which has just been completed by the Newton Machine Tool Works, of Philadelphia. The support of the arm will be seen to be of the trunnion type with a very substantial saddle having square lock bearings with overlapping gibs. Reversing power elevation is provided for the arm by means of tumble gears which are operated by the lever near the base of the column. The elevating screw has top and bottom bearings in order that it may be under tension when the drill is being fed to the work. The trunnion is fitted with roller bearings both cylindrically and on the bases. The spindle saddle is fitted to the arm with square locked gibbed bearings and all adjustments are made by taper brass shoes.

The motor drive to the spindle is transmitted through the horizontal and vertical shafts by means of steel and bronze bevel gears to a double train of clutched bevel gears transmitting motion to the vertical back-geared shaft on which spur gears mesh with the sleeve spur gears driving the spindle. The clutch engaging the high and low gears is mounted and slides on a quill driving the spindle by means of keys engaging with a double-spindle spline. The hand elevation of the spindle is obtained by the angular shaft operating the spiral gear and rack, and a hand wheel shown near the bottom and in front of the spindle saddle is provided for engaging the friction clutch to the feed, which is taken directly from the spindle by spiral gears and transmitted to the feed box, in which are mounted gears which are engaged by the clutch-pin lever shown above and to the left of the saddle, for changing the feed. The horizontal adjustment of the spindle on the rail is obtained by an angular hand wheel shown at the right of the saddle.

The machine has been developed from data gathered during the past two years from a number of prominent shops and it is expected to have a capacity greater than the best modern high-speed drills will stand. During a test made at the works of the maker a 3-inch Celfor drill running at 160 revolutions per minute was



SIX-FOOT RADIAL DRILLING MACHINE

fed into the work at the rate of 3 inches per minute and smaller drills in proportion. This Celfor drill is shown in position in the photograph which also shows some of the chips.

The machine is now being exhibited at the Atlantic City convention of the Railway Master Mechanics Association where the Celfor Tool Company has planned to conduct exhaustive tests upon it. The machine is driven by a motor supplied by the Western Electric Company who are taking instrument readings of the power required under different conditions, the tests being also intended to determine the feeds and speeds possible with the Celfor drills.

The leading dimensions of the machine are as follows: Maximum distance from center of trunnion to center of spindle 72 inches, minimum 24 inches; maximum distance from end of spindle to top of base 89 inches; diameter of spindle 4 inches; maximum length of feed 18 inches; range of spindle speeds from 0.0156 to 0.037 inches per revolution of spindle; range of spindle speeds from 70 to 300 revolutions per minute.

An Innovation in School Shop Practice

By G. H. Perkins*

The technical press has recently given much attention to the discussion of the methods, merits and results of the workshops of our technical schools. Numberless articles have appeared by practical mechanics, "college professors of machine-shop practice" and others interested in the matter, but there is apparently no agreement as to what is the most efficient method of operating a school shop to get results of practical value. Between the extreme views of those who insist that nothing useful can be learned right in a school and the academic notions of the pure theorists of industrial training who often consider that shop work is wholly of "psychological" value, there are many and varied opinions. Some would make such work wholly instructional in character while others would attempt to make a school shop serve a commercial purpose in addition to its function of training for usefulness. Admitting at once the impossibility of any school-shop training immature students into skilled workmen, the question arises, how can such work be done, retaining when possible the atmosphere and commercial features of a "real" shop, and not sacrifice the prime consideration of instruction?

In the plan to be described, the main object was to find a middle ground between the common methods employed in the majority of school shops, where the work is wholly educational in character, and the plan adopted at a few institutions where, with the aid of skilled paid journeymen, a commercial product is marketed in competition with outside shops. The first of these methods, while condensing the instruction in the typical operations of machine practice to a minimum of the student's time and energy, does it by using a carefully planned series of "projects" or models which have absolutely no value when done except for exhibition purposes or the scrap heap.

How can any student be expected to be intensely interested in the production of "play" models to be exhibited on graduation day and immediately afterward consigned to the junk pile or worked down to smaller dimensions for a similar exercise for the classes to follow. The commercial element in that sense of power which comes from the useful accomplishment of a real job is entirely lacking and there is no more important factor in the student's interest in and attitude toward his work than this. It is such methods doubtless that account largely for the "lukewarm" attitude of indifference toward school-shop work taken by many students who have in them the making of skilled and efficient mechanics.

The main objection to the methods of school shops, where a commercial product is put out in competition with the open market, is that while the students can perform certain simple operations of relatively minor importance, only skilled journeymen can give to the finished machine that certain and sure touch that distinguishes professional from amateur efforts and real shop results from those of the school. While such a plan as this is doubtless superior to the first method, there will always be a tendency, if the shop is to be even approximately self-sustaining, toward sacrificing the instruction for the benefit of the commercial side and this defeats the true object of the school shop.

The following plan for machine-shop practice I have had in successful operation for the past six months at the Lowell Textile school, Lowell, Mass. The shop practice is considered a most important adjunct to the specialized technical training in the textile industry given at this school, and the character of the instruction in this branch as well as all others is of the most practical character possible. This work is given in the department of textile engineering and is allied closely to the construction and repair of textile machinery. In both day and evening courses is given this instruction; the evening classes are free for residents of the city. The features of the plan to be particularly noted are those involving the coöperation of a commercial shop—the Kitson Machine Shop, Lowell, Mass. This shop builds high-grade textile machinery and is one of the most progressive concerns in the city.

The principal points may be briefly summarized as follows:

(a) The school purchases from the shop at the regular price per pound castings or forgings which are carefully selected by the shop superintendent and instructor for their representative value for instruction purposes.

(b) These castings or forgings are graded as to difficulty and represent as far as possible only one or at the most two typical operations.

(c) These castings or forgings are machined and finished in accordance with blueprints and specifications furnished by the shop and the actual shop methods are followed wherever possible.

(d) The instructor in direct charge of the work is assistant superintendent of the shop proper and is a most competent and experienced man. Arrangements have been made with the shop so that he devotes eight hours per week to the school work, four of which are given to the evening classes.

(e) The finished work, if fully conforming to the requirements of the shop inspection made by the instructor, is returned to the shop and credit is given not only for the weight per pound but also for the work performed upon it at a reasonable rate based on and determined from the shop cost.

The advantages of this plan when properly carried out with the coöperation of a commercial shop are:

1. A commercial element is introduced into the instruction work, thus holding the student's attention, and the inspection and acceptance of his work furnishes the strongest incentive for careful and painstaking performance.

2. The expense to the school is small, the value of the accepted work offsetting the cost of material and work rejected by inspection.

3. The school-shop equipment must consist of tools adapted for real shop work and not of the type so often found and built solely for school use.

4. The best type of practical instructor is furnished and as he serves only part time, a much higher-grade man than is ordinarily attracted to school shops is available.

5. The expense to the shop is negligible except the time allowed the instructor, and after a sufficient period of coöperation, experimental work of various kinds could be carried on in the school shop which would be of mutual benefit.

It must be understood that this plan is in no way intended to train men for the purposes of this particular shop nor is the shop a material gainer on the work done, which necessarily is not large in amount or value. The sole object is to give the student as practical a training in shop work as possible and create his interest in and for commercial work. Thus far the working of this plan is entirely satisfactory and would seem to be perfectly feasible and practicable wherever broad-minded manufacturers are willing to cooperate with the schools in a similar way.

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Convention of Pennsylvania Engineers

The first State convention of Pennsylvania Engineers was held at the capitol, in Harrisburg, on June 9, 10 and 11. So far as we know this is the first State engineering convention ever held in the United States, and in that respect it marks a forward step for the profession of engineering.

The activities of the convention readily group themselves under four heads; business, or the forming of a permanent organization and a discussion of an engineering code; professional papers by experts; social features, including a smoker and banquet, and a manufacturers' exhibit held in the largest hall in the city.

The call for the convention was sent out to some 5000 engineers by the convention section of the Engineers' Society of Pennsylvania, with the purpose of uniting them in a movement to formulate a code and later draft bills to be presented to the State legislature two years hence. At the session of the legislature just closed such a bill was introduced by interests unknown. It was deemed so pernicious, however, that the engineering societies of the State united to kill it in committee. This was done, but a pledge was given to the legislature that at the next session a bill, or bills, would be introduced, which would be indorsed by the engineers of the State.

At the business session on Wednesday afternoon Professor Jackson, of the Pennsylvania State College, was elected chairman, and proceeded to formally organize the convention and select certain committees.

The address of the afternoon was given by F. Herbert Snow on "Outlines of a Code with Legislative Backing." By vote, discussion was deferred until Friday, but hearty support of the idea of the code and of suitable State legislation was expressed. The secretary of the Society of Engineers of Western Pennsylvania, and a delegate from the Engineers' Club, of Philadelphia, stated the active interest of their societies in the movement and pledged support.

The illustrated lecture of the afternoon was delivered by Prof. J. T. Rothrock on forestry with particular reference to Pennsylvania. Its drift was a stirring appeal to the engineers to stem the tide of forest waste, and bequeath to their children forest-covered hills and power-producing streams, instead of barren and eroded lands and gullies ultimately devoid of water and filled with destructive freshets.

Over 60 firms showed their product in the manufacturers' exhibition. It is impossible to mention them all here; those selected for reference have more direct bearing on machine building, although many other interesting and instructive lines of manufactures were shown.

The Harrisburg Foundry and Machine Works had a governor wheel and details of Fleming-Harrisburg engines; they extended to each engineer a cordial printed invitation to visit their plant. The Central Iron and Steel Company's booth contained sample bends of plates and bars, specimens of flanging and several steel railroad ties. A profusion of nuts, bolts, lag screws, turnbuckles and associated articles was shown by the American Iron and Steel Company.

A booth always surrounded by a crowd was the one at which lifting magnets were demonstrated by the Electric Controller and Manufacturing Company. Another working exhibit was a blueprinting machine, washer and drier, built by the Williams, Brown & Earl Company. A booth at which everyone who wished received something, was that of the McGraw Publishing Company, where specimen copies of their technical periodicals were shown.

Wednesday Evening Smoker

The first of the purely social features of the convention was the smoker, held in the auditorium of the Board of Trade building. Some 500 engineers enjoyed the cigars, lunch, songs, stories, and a few acts from the local theaters. Everything was well planned and well executed by the committees and well received by the guests.

Thursday Sessions

After a brief business session, held in the Senate chamber of the Capitol building, which received preliminary committee reports, three professional papers were presented: "The Disposal of Sewage," by F. Herbert Snow; "Gas Engines," by E. T. Adams; "Preservative Treatment in Relation to Cross-tie Supply," by E. A. Sterling.

At the afternoon session five papers were read by their authors, the first three illustrated by lantern slides: "Relation of Electric Furnaces to Siderurgy," by P. McNiven Binnis; "A Few Notes on Telephone Construction," by Nathan Hayward; "Electrification of Railroads," by Fredcrick Darlington; "Water Purification," by George A. Johnson; "Disposal of Manufactural Waste Separately and in Conjunction with Normal Sewage," by Frank A. Barbour.

In the evening a large and enthusiastic audience listened to and saw a pictorial story of the engineering work that has been done and is in progress on the Isthmian canal. The speaker was Lieut.-Col. H. P. Hodges, Corps of Engineers, U. S. A., assistant engineer Isthmian Canal Commission.

Colonel Hodges briefly reviewed the history of the canal, referred to the recent attacks upon the lock type, took up these attacks point by point and showed the fundamental engineering reasons that lie at the foundation of the decisions that had been made in regard to type. This part of the lecture was most convincing, and we fail to see how any unbiased engineer can favor the sea-level project after such a clear exposition of the tremendous difficulties and unknown factors that its building would involve, to say nothing of the cost and time required for completion. An attack on the canal type is now an attack on the canal project itself.

Drawings of the locks and gates were shown for the first time to an American audience; indeed, these drawings in detail have been finished but a short time.

The audience was enthusiastic in its reception of the views showing living conditions in the Canal Zone, the work done and machinery employed.

Friday's Business Session

At the final business session a resolution was adopted instructing the executive committee of the convention to invite each of the engineering societies of the State to elect three members of a general committee to work out a draft of the desired engineering code. Very wisely the details of the work of this committee were left to the committee itself, with power to effect its own organization. Upon this committee devolves the most arduous work mapped out by the convention.

A resolution was adopted instructing the chair to appoint a large committee composed, as far as practical, of one member from each county, to aid in ascertaining and crystallizing the engineering sentiment of the State, in discussion of the draft of the code to be drawn up and in intelligently placing before the members of the next legislature the need and character of legislation desired by the engineers of the entire State.

The permanent organization of the convention, as it stands, consists of a chairman, vice-chairman, secretary, executive committee of three, general committee on code and a large committee of county members.

The advisability of sections of the convention embracing members in the same field of activity was expressed in a suitable resolution. A delegate from Pittsburg raised a very pertinent point in stating that he failed to see how the engineering code and legislation would aid the average mechanical engineer, particularly the one employed by corporations.

Suitable resolutions were voted expressing appreciation to the State officials for use of the Capitol building, to the Harrisburg city government, to the many exhibitors and to speakers who contributed professional papers. Five such papers were presented on this, the last day of the convention: "Concrete Bridges," by Daniel B. Luten; "Pavements," by James Owens; "Low-pressure Steam Turbines," by J. G. Callan; "Conservation," by John

Berkinbine and "Dirt Roads," by Alva Agee.

The closing feature of the convention was a banquet in the auditorium of the Board of Trade. This was enlivened by toasts and responses and an illustrated story of some of our great government reclamation work in the West; work whereby thousands of acres of arid land are made fertile and suitable for American homes. Surely this is work of which American engineers can well be proud! The speaker was Arthur P. Davis, Chief Engineer of the U. S. Reclamation Service.

This report should not close without reference to the labors of President Snow, of the Engineers' Society of Pennsylvania, and of Professor Jackson, the chairman of the convention, which were largely instrumental in bringing about the marked success of the meeting, which is, perhaps, best shown by a registration of over 750.

Should Screw Threads Have a 60-degree Angle at Right Angles to the Helix?

By L. E. Dudley

Our shop has decided to adopt the A. S. M. E. standard threads, and is, like many others, passing through the throes of thread-gage evolution.

The gage-making department is my especial protegé, as it is, to my mind, the mainstay of the quality of our product, and I have, therefore, always made it my practice to see that everything was done in the gage room in the most carefully thought-out way, as well as by the most accurate methods and have always found this procedure a paying one.

Thread gages are seemingly, especially to the uninitiated, and by this I mean the majority of educated engineers and mechanics with whom I have come in contact during my career, one of the simpler problems in mechanics. I thought so myself until the fact had been brought home forcibly a number of times that properly fitting interchangeable threads were rarely attained, and then never maintained for any length of time in our shop, and that this condition constituted our weak point and caused a varying quality in our goods.

On investigation our system seemed all right; we bought our thread plugs and templets from the foremost manufacturer in this line, our taps and dies from a prominent firm with high standing, and our screws and nuts from the manufacturer bearing the best reputation for quality, but the system had failed our needs.

On going deeper into the matter we found various causes for the trouble, the two most important of which were slightly varying standards, or different interpretations of the same standards, and inaccurate work resulting in difference of lead and interference of diameters on gages, tools and screws. We decided at any cost to overcome these troubles and installed machinery and tools to make our own gages, templets, taps, dies, screw, nuts, and, in fact, to hold the whole situation in our own hands. This proposition gave us many a bad half hour, and after many trials and tribulations we formulated a system, upon which I may touch at some other time, by which our producing troubles were practically ended.

As our business is growing rapidly and the demand for gages, taps, screws, etc., is growing to where it will be eventually beyond our present equipment to supply it, and as we do not wish to increase this equipment because our records show that it costs us considerably more on the non-productive side of the business to do these things ourselves than to buy of others, we are receiving the new universal interchangeable A. S. M. E. standard with open arms, hoping that we will be able to buy taps, dies, screws, gages, etc., made according to this decimal system, which will be sufficiently good for our less particular classes of work at least, and which will still be more or less in conformity to the same standard as applied to our better classes of work. We have, however, decided to make our own master reference gages, a good many working gages and also taps and dies enough to start us along the right path before doing any outside buying.

After completing our first set of gages we are suddenly brought face to face with a condition which makes us feel weak in the knees, a nervous affection which oftens accompanies clear "hind-sight." Through lack of as clear fore-sight, or rather from a false sense of security we went ahead, made elaborate but necessary arrangements for a better job than we had ever done before at a very considerable expense, and now find that our measuring arrangements, pitch micrometers, wire system, ball points and all, do not measure as the figures given by the society in their reports indicate that threads should be measured. That is, the society diagrams and figures show that the 60-degree angle of the thread should be measured *parallel to the axis* and at an *angle to the helix* of the thread equal to the angle of the lead. Our measuring arrangements all measure at *right angles to the helix* or at an *angle to the axis* equal to the angle of the lead of the thread.

What brought this to light and proves this matter to be quite serious in connection with accurate gage making is that we had two duplicate (?) thread plugs made and on checking their pitch diameters with the wire system we found them identical, and perfect in lead, outside diameter, etc., but found, when measured for pitch diameter with a thread micrometer, a difference was plainly discernible, and further that when a thread templet was adjusted to the one, the other either entered loosely or not at all.

The cause of the trouble was found to be in a new thread tool made with a cutter head which swiveled vertically and which had been left for trial by a salesman with the head gage maker, he had tried it out with the top face of the cutter horizontal for one gage and had inclined it to conform to the helix for the other working the pitch diameter by the wire system.

To satisfy myself that there was no other cause for the trouble I had a number of gages made under both conditions, and though we had no trouble in checking gages made with the tool in the same position, with each other by the various measuring methods, we found that when both gages fitted the templet they gave different comparisons with the wire system and thread micrometer, and when they checked together with the wires, a different result was obtained with the micrometer, and *vice versa*.

Now, where are we at? The society gives us theoretical figures to follow based on one system; measuring-tool manufacturers and any readily applicable methods of measurements give us a practicable way to measure threads based on a radically different system, and along comes an obliging thread-tool manufacturer who puts the means in our hands to follow either system we choose.

Which way, gentlemen, which way do we jump?

Forthcoming Meetings

Railway Master Mechanics Association, annual convention, June 16-18, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

Master Car Builders Association, annual convention, June 21-23, Atlantic City, N. J. Jos. W. Taylor, secretary, Old Colony building, Chicago, Ill.

National Gas and Gasolene Engine Trades Association, meeting, June 22, 23, 24, South Bend, Ind., headquarters, Oliver hotel. Albert Steitwatter, Cincinnati, Ohio.

Society for the Promotion of Engineering Education, seventh annual convention, June 24-25-26, Columbia University, New York, and Pratt Institute, Brooklyn, N. Y. Arthur L. Williston, secretary, Pratt Institute, Brooklyn, N. Y.

The Society of Naval Architects and Marine Engineers, summer convention, June 24-26, Detroit, Mich., headquarters, Hotel Pontchartrain. W. J. Baxter, secretary, 29 West Thirty-ninth street, New York City.

American Society of Testing Materials, annual meeting, June 29, Atlantic City, N. J., Edgar Marburg, secretary, University of Pennsylvania, Philadelphia, Penn.

Business Items

Farrel Foundry and Machine Company, Ansonia, Conn., has opened a branch office at 1011 Williamson building, Cleveland, O., George W. Osborne, manager.

The Jacobs Manufacturing Company, Hartford, Conn., manufacturers of drill chucks, is putting in additional machinery and enlarging its capacity to take care of the increased demand for its product.

Business Opportunities

The Grand Rapids (Mich.) Stove Company will enlarge its plant.

The Gemmer Engine Company, Pontiac, Mich., will erect a new shop.

The Marietta (Ohio) Chair Company is to erect a new six-story factory.

The Atlas Flour Mills, Milwaukee, Wis., is adding two stories to its mill.

The Cleveland (Ohio) Electric Illuminating Company will build an addition.

The Boyne City (Mich.) Tanning Company will erect an addition to plant.

The Melville Woolen Company, Fredericksburg, Va., will erect an addition.

The National Cycle Works, Bay City, Mich., will build two additions to plant.

The Lewis Knitting Company, Janesville, Wis., will erect an additional factory.

The foundry and machine shop of J. S. Getchell & Sons, Caribou, Me., was burned.

The Acme Universal Joint Company, Kalamazoo, Mich , will erect a new factory.

It is said a new building will be built for the Barnes Gear Company, Oswego, N. Y.

Albert Trostel Sons' Leather Company, Milwaukee, Wis., is building an addition.

Crohon & Roden Company, Grand Rapids, Mich., will erect a large new tannery.

The Christianson Metal Shoe Company, Racine, Wis., will build a new factory.

The Watertown (Wis.) Gas and Electric Company will erect a new power house.

L. W. Weyenburg Shoe Company, Chippewa Falls, Wis., will erect a five-story factory.

The Barnum Trunk Company, Minneapolis, Minn., will erect a new three-story factory.

Luther Lindauer, South Kankanna, Wis., will build pulp mill at Little Rapids, Wis.

The tannery of the E. C. Fisher Company, Bethel, Vt., recently burned, is to be rebuilt.

The Enamel Steel Closet Tank Company, Kalamazoo, Mich., will erect a new building.

The Bessemer Gas Engine Company, Grove City, Penn., will erect an addition to plant.

James D. Flynn, of Ardmore, Okla., is to establish a $50,000 foundry at Sapulpa, Okla.

The foundry at the penitentiary at Salem, Ore., recently destroyed by fire, is to be rebuilt.

The Seibert Johnson Company, Hudson, Wis., will build addition to sash and door factory.

The Rochester (N. Y.) Railway and Light Company will erect an electric automobile repair shop.

J. G. Oberhelman, Cincinnati, Ohio, will erect a new foundry in the Camp Washington factory district.

The Handknit Hoisery Company, Sheboygan, Wis., will build a new factory to cost about $10,000.

The Metric Metal Company, Erie, Penn., manufacturing water and gas meters, is enlarging its plant.

The Hawkeye Pearl Button Company, Muscatine, Iowa, will establish a branch business in Keokuk.

The Vans Harbor (Mich.) Land and Lumber Company will erect a new mill to replace the one burned.

The Dublin (Ga.) Buggy Company is to build an addition and engage in the manufacture of automobiles.

The Chippewa Falls (Wis.) Woolen Company will build a new mill and also two-story addition to boiler room.

Henry Disston Sons, of Philadelphia, Penn., manufacturing saws, files, etc., are to erect a plant in Toronto.

The Nordyke & Marmon Company, Indianapolis, Ind., is in the market for new tools for automobile work.

The Virginia Mechanics' Institute, Richmond, Va., is to install a machine shop and blacksmith shop this summer.

The Freeland Steam Tank Company, Sturgis, Mich., will locate at Portage, Wis. New buildings will be erected.

C. C. Waller, Krupp & Tuffly building, Houston, Tex., is said to be interested in plan to establish $300,000 car works.

The Twin City Stone Company, Marinette, Wis., will erect building for manufacturing concrete blocks, etc.

The Mesaba Iron Works, Virginia, Minn., is erecting a new plant, including foundry, machine shop and forge room.

The Western Motor Company, Logansport, is not moving its plant to Marion, but erecting an additional factory.

E. J. Vandreuil, Two Rivers, Wis., will build a canning factory near Warrens, Wis. The town is to be called Vandreuil.

The plant of the California Fruit Canners' Association, at Fresno, Cal., was destroyed by fire. Loss, about $500,000.

The Massillon (Ohio) Rolling Mill Company, it is said, will enlarge capacity of plant by the addition of more steel mills.

The Bury Compressor Company, Erie, Penn., is in the market for a gas engine, to run its contemplated addition to shop.

The lumber and shingle mill of Smith, Hurst & Schneider at Grand Marais, Mich., was destroyed by fire. Loss, $10,000.

The Heywood Manufacturing Company, Minneapolis, Minn., making paper boxes, etc., will erect a new $150,000 factory.

Gotfredson Bros., Green Bay, Wis., will erect a central heating plant and will also include an auto garage, paint shop, etc.

A new brick plant is to be established near St. Ignace, Mich. M. Van Orden, Houghton, Mich., is president of the concern.

The A. O. Smith Company, Milwaukee, Wis., manufacturing automobile parts, will erect a new plant to cost about $500,000.

The sawmill, planing mill and dry kilns of the Skagit Mill Company, Lyman, Wash., were destroyed by fire. Loss, about $100,000.

The Maxwell-Briscoe Company, New Castle, Ind., is inquiring about lathes, milling machines, etc., for a proposed enlargement of its plant.

The plant of the Pittsburg-Hickson Bedstead Company, at East Butler, Penn., is to be enlarged by the erection of two additional buildings.

Plans have been prepared by John H. Windrim, architect, Philadelphia, Penn., for addition to foundry and shop building at Girard College.

The Rockwood Mills, Rockwood, Tenn., will build a $11,000 addition to its mill and also install machinery for the making of paper boxes.

The Orono (Me.) Pulp and Paper Company is building an addition to its mill to be used as a boiler room. New boilers will be installed.

The Williams Foundry Company, Vineland, N. J., is erecting a new foundry. The company makes a specialty of knitting-machine castings.

The Marsden Brass Foundry Company, Milwaukee, Wis., is building a new foundry for the manufacture of aluminum brass and bronze castings.

The Interborough Rapid Transit Company New York, has taken out a permit for new barns and shops to replace those recently destroyed by fire.

It is reported the mechanical engineering department of the University of Arkansas, Fayetteville, Ark., contemplates the installation of new equipment in shops and laboratory.

The Armstrong Buggycar Company, Atlanta, Ga., a new concern, will erect plant and install automobile machinery to cost $10,000. D. D. Armstrong, Century building, is manager.

The Valk Manufacturing Company is erecting a plant at Topeka, Kans., for manufacturing mining and irrigating pumps, gas and gasolene engines. About $200,000 is to be expended.

The Davenport (Iowa) Ice Chipping Machine Company has taken over the gasoline engine business of the White Lily Washer Company and expects to erect a new factory in the near future.

A. R. Weiss, Maximilianowskaja 12, Moscow, Russia, agent, would like catalogs of automobiles, agricultural machinery, railway tools and supplies, machine tools, miners' tools, fuel economizers.

The Morris Sherman Manufacturing Company, Chattanooga, Tenn., will start erection of proposed new plant to replace the present one. The company manufactures boilers, structural steel, etc.

J. F. Rothe, Green Bay, Wis., will purchase within 60 days following foundry equipment: Cupola, furnace blower, rattler, electric elevator, 10-ton electric crane, nine electric motors, 3 to 25 horsepower.

M. E. Varadachariar, agent of the Conjeeveram Industrial Company, Ltd., Conjeeveram, near Madras, India, would like catalogs and price lists of agricultural implements, brick and tile machinery and pumps for irrigation.

Herman Sielcken, of Crossman & Sielcken, coffee importers, New York, has bought the Woolson Spice Company, at Toledo, Ohio, and will build a new plant, which, it is said, will be the largest coffee roasting plant in the United States.

J. L. H. Smits & Co., Warmoesstraat No. 42, Amsterdam, Holland, dealers and agents, are open for business in the following goods: Machine tools, woodworking machinery, small tools, drills, emery wheels, belting, pumps, pipes and fittings.

The Electric Welding Products Company, Cleveland, O., has just completed a new three-story addition to its plant which will give it nearly double the present manufacturing floor space. The greater part of this new addition will be equipped to handle gas-engine and motor-car parts.

The American Automatic Stoker Company is negotiating for a site for plant in Blomington, Ill., the company's product now being made by outside parties. D. W. Ross, 165 Broadway, New York, is president, and J. J. Hannahan, Railway Exchange building, Chicago, is general manager.

The Isthmian Canal Commission, Washington, D. C., will receive bids up to 10:30 a.m., July 19, for machinery for central pumping station and three pumping units for hydraulic excavating and sluicing, including pumps and motors, engines, boilers, monitors, pipes and fittings, etc. as per Circular No. 516.

The Puget Sound Machinery Depot, Seattle, Wash., is in the market for machinery for its new shop, including 72-inch vertical boring mill, 36-inch triple geared lathe, 18-inch quick change lathe, 24-inch turret lathe, 48-inch by 14-foot planer, one side; 24-inch shaper, drills, key-seater, plulley lathe and power hack saw.

The Portland (Ind.) Foundry and Machine Company has voted to increase its capital stock for the purpose of building a new plant, to consist of grey iron foundry, machine shops, boiler shops and supply store. It will add a drop forging plant later. The firm would like to hear from manufacturers of modern equipment.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open the following bids: June 22—Crucibles, water gages, thermometers (schedule 1330); rail cutting machine (schedule 1326); fan motors (schedule 1325); differential blocks (schedule 1330); steel bolts, reamers, beam scales, machinists' vises (schedule 1323); hose clamps,

grommets, etc. (schedule 1322); steel angles, castings, plates (schedule 1328); pig iron, scrap iron, solder (schedule 1330); rolled bronze, sheet copper (schedule 1329); bolts, angles, rails, switches, track tools (schedule 1326). June 29—Electric traveling hoist (schedule 1304); feed water heaters (schedule 1317). July 6—Steel boiler (schedule 2); pipe covering (schedule 8, 4); wrought iron pipe, radiators, steel registers, globe valves, plumbing supplies (schedule 2).

New Incorporations

The J. Kennedy Machine Company, Cohoes, N. Y., has been incorporated. Capital, $10,000. Incorporators, Thos. Kennedy, T. F. Kennedy, E. A. Kennedy.

United Lock Washer Company, Springfield, Mass., has been incorporated to manufacture machine fittings. Capital, $50,000. Incorporators, H. F. Parcher, A. C. Harvey.

The Goodnow-Edmonds Company, Boston, Mass., has been incorporated. Capital, $50,000. Incorporators, R. J. Goodnow, M. Edmonds. Will manufacture iron, brass, steel, etc.

The C. M. C. Wrench Company, Syracuse, N. Y., has been incorporated to manufacture wrenches, etc. Capital, $15,000. Incorporators, W. B. Coe, Chas. Miller, Jas. J. Boyd.

The Pittsburg Motor Vehicle Company, Washington, D. C., has been organized to manufacture electric delivery and truck cars. Arthur C. Moses, 1100 F street, N.W., is president.

Bachmann's Aeroplane Company, Newark, N. J., has been incorporated to manufacture flying machines, etc. Capital, $30,000. Incorporators, F. Bachmann, F. G. Dehe, J. Mossman.

Palmer Sheet Metal Works, Inc., New York, to manufacture sheet metal work, roofs, skylights, etc. Capital, $30,000. Incorporators, W. E. D. Vincent, J. T. Sullivan, H. A. Bloomberg.

Penn Automatic Machine Company, New York, incorporated to manufacture musical slot machines and multiphones. Capital, $60,000. Incorporators, A. Simon, D. H. Singer, A. J. Turner.

The Pearson Paper Box Company, Kansas City, Mo., has been incorporated with $12,000 capital to manufacture paper boxes. Incorporators, Thomas Pearson, L. H. Barker, G. V. Pearson, etc.

The Auburn Auto-Pump Company, Auburn, N. Y., has been incorporated to manufacture automobile and other pumps. Capital, $25,000. Incorporators, E. N. Rose, R. J. Berham, C. W. Storke, L. Heazlit.

Tribe Automatic Headlight Company, Worcester, Mass., has been incorporated to manufacture headlights for automobiles, locomotives, street cars. Capital, $200,000. Incorporators, F. Pharoah, T. Tribe.

Automatic Welding Company, New York, has been incorporated to manufacture automatic machinery, etc. Incorporators, E. J. Forhan, H. M. Browne and J. J. Harper, No. 154 Nassau street, New York.

The Indicator Electric Company, Chicago, Ill., has been incorporated to manufacture electrical and mechanical appliances and devices. Capital, $30,000. Incorporators, M. R. Leahy, A. A. Radtke, G. E. Gorman.

The Elsner Machinery and Manufacturing Company, St. Louis, Mo., has been incorporated to manufacture, buy and sell machinery. Capital, $10,000. Incorporators, Joseph Elsner, E. C. Brockman, W. T. Jones.

The Electric Service Company, New York, has been incorporated to manufacture automobiles and accessories. Capital, $50,000. Incorporators, W. L. Ernst, A. A. Ernst, New York; M. E. Harby, Huntington, L. I.

New Catalogs

Smooth-On Manufacturing Company, Jersey City, N. J. Third edition of Smooth-On Instruction Book No. 7. Illustrated, 4½x6½ inches.

The Gardner Governor Company, Quincy, Ill. Bulletin No. 143, describing Gardner-Rix vertical high-speed air compressor. Illustrated, 8 pages, 6x9 inches.

Jacobson Machine Manufacturing Company, Warren, Penn. Bulletin No. 27, describing gas and gasolene engines. Illustrated, 24 pages, 6x9 inches.

Whiting Foundry Equipment Company, Harvey, Ill. Booklet for Cincinnati Convention, entitled "A Model Foundry." Illustrated, 32 pages, 6x9 pages, paper.

Milwaukee Locomotive and Manufacturing Company, Milwaukee, Wis. Publication No. 100, describing gasolene-driven locomotives. Illustrated, 28 pages, 6x9 inches.

Want Advertisements

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendation or other papers of value should not be inclosed to unknown correspondents. Only bona fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

Miscellaneous Wants

Caliper list free. E. G. Smith, Columbia, Penn.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Hand power bending tools, labor-saving, money-making. Estep & Dolan, Sandwich, Ill.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

A large foundry and machine shop desires to add to present lines of manufacture. Box 126, AMERICAN MACHINIST.

Wanted—Designs and prices of machines for tapping iron pipe fittings two to six inch. Box 126, AMERICAN MACHINIST.

Machines designed; automatic, special. Practical working drawings. C. W. Pitman, 3519 Frankford Ave., Philadelphia, Pa.

Special machinery accurately built. Screw machine or turret lathe work solicited. Robert J. Emory & Co., Newark, N. J.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Wanted—To manufacture, in modern fireproof machine shop, small specialties in brass or iron. Box 273, AMERICAN MACHINIST.

If you have a tool or similar device which you wish to sell or have manufactured on royalty, address Box 289, AMERICAN MACHINIST.

Wanted—Manufacturer for specialty; light work. Will exchange Norfolk real estate for first order; large quantities will be wanted later. Box 308, AMERICAN MACHINIST.

Wanted—From 500 to 1500 horsepower of B. & W. water tube boilers in units of 250 horsepower each. Must be in A-1 condition. Inquire of J. F. Cargill, Room 1630, Frick Building, Pittsburg, Pa.

A large English firm of machine-tool importers having showrooms and offices in Great Britain, France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Special machines designed and built, estimates furnished; inventions developed to a practical and commercial basis. Benj. Brownstein, mechanical engineer and expert designer, Gundling Bldg., Trenton, N. J.

English engineer, now in Chicago, would be glad to receive proposals from manufacturers desiring representation or sales agency in England or any part of Europe; highest references. Box 324, AMERICAN MACHINIST.

Auction Sale—The machinery and tools of the former A. A. Griffing Iron Company, Jersey City, N. J., on July 7 and 8, at 11 o'clock a.m., consisting of a variety of machine tools, lathes, planer, drills, Ingersoll 10'x48" miller with tool sharpener, eight arbors, Pedrick & Ayer pneumatic and air hoists, foundry cranes, 125-horsepower Ball tandem engine, Norwalk air compressor, pumps, chain hoists, vises, belting, office furniture, Mosler safe, etc. Catalogs after June 21 on application by mail or otherwise, to F. W. Smith, 104 West 42nd St., New York.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Factory accountant and systematizer desires to install and supervise a system of factory accounting which will produce advantageous results. Box 296, AMER. MACH.

FRANCE

General superintendent of motor-car factories (French) knowing American practice, would take similar position in American shop wanting French experience; has been for several years with De Dion Bouton, Clement Bayard and Lorraine Dietrich; thoroughly up-to-date and a hustler. R. Leyrit, Bezons (Seine & Oise), France.

KANSAS

Wanted—Position as superintendent or foreman of marine or automobile plant fully experienced on both; also on high grade two and four cycle motors. A systematizer and a hustler. Address "Two Cycle," AMER. MACH.

MASSACHUSETTS

Machinist, worked for present employer eight years, wishes to make a change. Am 31 and married. Prefer sewing machine work in factory. Box 309, AMERICAN MACHINIST.

Practical mechanic; broad experience as general foreman and superintendent; good executive ability; has thorough knowledge of modern shop practice; the use of high-speed steel and interchangeable manufacture; American; 35. Box 282, AMERICAN MACHINIST.

NEW JERSEY

Mechanical engineer, chief draftsman and designer; experienced in steam engineering and pumping machinery, is open for responsible position. Box 301, AMER. MACHINIST.

Young man, toolmaker and machinist, some technical education, having managed own shop for seven years, desires position as superintendent, manager, purchasing agent or representative. "F. F.," Box 306, AMER. MACH.

NEW YORK

Superintendent of large successful concern desires change. Box 235, AMER. MACHINIST.

Machine patternmaker with 15 years' experience wants a position in an open or non-union shop. Box 300, AMERICAN MACHINIST.

Position as superintendent or assistant by engineer 35 years old, experienced in refrigerating machinery, gas engines and automobiles. Box 323, AMERICAN MACHINIST.

Up-to-date mechanical engineer with 12 years' experience in designing and manufacturing fine and general machinery, also tools; wants to change. Willing to go anywhere. Box 285, AMERICAN MACHINIST.

Wanted—By first-class mechanic, well up in modern tool-room and machine-shop practice, position as tool-room foreman or general machine-shop foreman. Can furnish the best of references. Box 302, AMER. MACH.

Designing engineer, 17 years' experience, educated; practical mechanic, expert on automatic machines, both light and heavy, and tools. Capable, original, successful. Any locality. $2500 per year. Box 286, AMER. MACH.

Mechanical and electrical engineer, technical graduate, 13 years in shop, drawing room and office; can handle men; now employed; past three years spent as superintendent of the erection, equipment and operation of an engineering experimental station; desires to obtain position as assistant to consulting engineer, or, as superintendent of manufacturing plant. Salary, $5000 if position has a future. Location in Pennsylvania or New York preferred. Box 320, AM. MA.

OHIO

Designing draftsman desires change, technical education followed by seven years' practical experience as draftsman, general foreman and assistant superintendent in construction of general machinery for the drilling and operation of oil and gas wells. Thirty years old, married, good references. Box 316, AM. MACH.

PENNSYLVANIA

Young man having five years' experience in office of gear jobbing company understanding details and trade, desires change. Box 321, AMERICAN MACHINIST.

Tool and diemaker with broad training on

all kinds of tools, long experience in sheet-metal work; also experimental work; could handle men to advantage. Box 319, AM. MA.

Member American Society of Mechanical Engineers, age 40, desires position as assistant superintendent or designer of special machinery; has had experience with paper bag and envelope machinery and steam disinfecting and sterilizing apparatus; nine years superintendent of large blower works, four years with largest manufacturer of power transmission apparatus. Box 318, AM. MA.

Wanted—Responsible position by a young man with 20 years' experience as machinist, draftsman, foreman and manager. Experienced in the design and manufacture of light and heavy machinery, foundry work, interchangeable parts, shop and cost systems, buying, selling and credits. Can take charge of entire plant or will represent manufacturer. Employed now, but desire change. Box 305, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT

Wanted—A new company starting its factory in Connecticut desires applications for employment from draftsmen, foremen, toolmakers and general machine operators. The work is along the line of adding machines, fire arms and typewriters, requiring interchangeable parts and high grade workmanship. Men having experience in this line of work, who can prove themselves capable men, are desired only. To such men permanent positions are offered, with ample opportunity for advancement. In reply, give age and references, which will be treated confidentially if so desired. Box 314, AMERICAN MACHINIST.

INDIANA

Two experienced foremen for machine and assembling rooms, manufacturing gasolene motors. Give reference, experience and age. Box 262, AMERICAN MACHINIST.

Wanted—Man experienced in case-hardening and heat-treating small carbon and nickel-steel parts; state age, experience and give reference. Box 322, AMER. MACH.

MARYLAND

Wanted—Three or four first-class draftsmen on heavy machinery and marine engines. Box 317, AMERICAN MACHINIST.

MASSACHUSETTS

Wanted—Mechanical designer experienced on both light and heavy work, for position in Massachusetts. State age, experience and salary expected. Address "ZYX," care AMERICAN MACHINIST.

Wanted—At Leominster, Mass., mechanical draftsman with experience in hydraulic and general line of machinery; state age, nationality, technical and practical training, previous employment and salary expected. Address Box 152, Leominster, Mass.

First-class, experienced mechanical draftsman and designer, familiar with high-speed steam-engine design, wanted for permanent position in large manufacturing concern in Massachusetts; give full particulars as to age, education, experience and salary expected. All information will be treated as confidential. Address Box 299, AMERICAN MACHINIST.

MICHIGAN

Wanted—A few first-class toolmakers on small work; good wages and steady employment for competent men. Box 278, AM. MA.

MINNESOTA

Wanted—First-class salesman, calling on machine shops, to sell as a side line, a speed shifter just patented. Can be easily attached to any machine at a very small cost. Is highly recommended by those who have installed them. Address Diamond Speed Shifter Co., 1728 2d St., No., Minneapolis, Minn.

NEW JERSEY

Wanted—Expert tool and die maker for calculating machine parts. State experience and wages expected. Box 304, AMER. MACH.

Wanted—Working foreman for metal pattern department; one who has also a general idea of wood work and has had experience in agricultural work. Answer, stating age, experience and wages expected. Box 311, AM. MACH.

NEW YORK

First class blacksmiths and tool dresser wanted Maxwell-Briscoe Motor Co., Tarrytown, N. Y.

Wanted—A designing draftsman having experience on papermaking machinery. None others need apply. One having machine shop experience preferred. Box 310, AMER. MACH.

Wanted—By concern in vicinity of New York assistant in mechanical engineering department. Must have had technical education and practical experience in production and erection of elevators. Give age, experience, references and salary expected. Box 313, AMERICAN MACHINIST.

OHIO

Wanted—Designer and draftsman; one who understands designing and general line of drilling machines; only experienced man who can give best reference and has shown results need apply. "Machine Tool," AMERICAN MACHINIST.

PENNSYLVANIA

Machinists wanted. Lathe, boring mill and floor hands, air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—A good practical die maker, who has had experience in making sheet metal drawing, combination and other dies. Only those having practical experience need apply. Address, stating where you have worked, wages expected, etc., Box 1023, Pittsburgh, Pa.

We have an exceptional opening for an exceptional man. Small manufacturing plant, water power, cheap help and other expenses low. Output contracted to 1911. Want a man who will invest $5000 or more and take an active part. Must be a hard worker, willing to accept small salary to start and to get in and *dig*, that we may *grow*. "Metal Work," care AMERICAN MACHINIST.

Wanted—A good live agent in every shop or factory in the U. S. to sell one of the best known preparations for removing grease and grime from the hands without injury to the skin. Absolutely guaranteed. An agent can make from $5.00 to $25.00 over and above his regular salary. This is no fake. Write for free sample and agents' terms. The Klenzola Co., Erie, Pa.

WISCONSIN

Wanted—To correspond with first-class draftsman who has had thorough experience. Wood working machinery line preferred. Box 315, AMERICAN MACHINIST.

Wanted—First-class draftsman, tinner and floor hands. State age and give experience in detail. Must be familiar with automobile work. Box 312, AMERICAN MACHINIST.

For Sale

For Sale—One 40-horsepower Buckeye late model engine; one Imperial 22-kilowatt, 125-volt, direct-current generator. Both A-1 condition. Address the Woods Engineering Co., Alliance, O.

For Sale—Two 1-ton Yale & Towne chain twin-hoists. Used 5 months; in good condition. Hurley Track Laying Machine Co., Chicago, Ill.

For Sale or to Rent—A fully equipped, up-to-date foundry and machine shop, erected 1907, situated on Erie Railroad. Address Lock Box 30, Savona, N. Y.

For Sale—Valuable improved combination depth scale with patent; useful in several different ways along toolmakers' and machinist line. Full particulars, write. Wm. J. Gillard, No. 3617 Chicago Ave., Minneapolis, Minn.

For Sale—The only foundry in a large lead field. Well established, best equipment, good iron-clad buildings, own water works. Have done a good business all along the hard times. Will sell for one-half of actual cost, which is $16,000.00. Box 288, AMERICAN MACHINIST.

For Sale—No. 12 Higley cut-off saw with grinding attachment and extra blade, new; Westinghouse direct-current motor, No. 5, type S, 15-horsepower, 500-volt, 1150 revolutions per minute on sliding base, switch and starting box, new. Address Hilliard Clutch & Machinery Company, Elmira, N. Y.

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